EDITORIAL

ON April 18 next, San Franciscans will recall the happenings ten years ago with a shudder for the disaster and a pardonable pride in the city that was erected upon the ruins of old San Francisco as a monument to the courageous spirit of its people. It is this spirit, rather than sky-scrapers, hotels, or places of amusement, that constitutes the real San Francisco.

WITH this issue is inaugurated the fifth year of the journalistic life of WESTERN ENGINEERING. The editorial and business staffs desire at this time to express to contributors, subscribers, and advertisers their appreciation for the support that has made possible the progress that has been made. There is no better exemplification of the advantages of co-operation than in an enterprise of this kind. We hope that our readers and advertisers enjoyed the friendly relations that have thus been established to the same degree as ourselves, and we can pledge our best efforts toward a continuous betterment of the service.

COST-KEEPING is, or should be, an essential part of an engineer's education. It is nearly as important to know accurately what work costs as it is to execute it skillfully, and the credit for many a good job has been overlooked on account of the inaccuracy or crudity of the cost-keeping methods. Mr. G. Ed. Ross has contributed an article in this issue that should go far toward elucidating the principle of cost-keeping and render easy the development of a system applicable to highway construction and other kinds of engineering work. In this connection it is interesting to note, that since the article went to press, we have received word of a number of counties in Oregon which are preparing to install Mr. Ross's system, with the object in view of having all highway records uniform throughout the State.

AN interesting retrospect of the Panama-Pacific Exposition is afforded by statistics recently given out by the Publicity Department, through which we learn that nine hundred and twenty-eight conventions were held in San Francisco during the Exposition period. Of these, fifty-six were classed as scientific, in which we presume the engineering congresses were included. The estimated total attendance at all sessions is given as 1,756,000, in which are probably included the authors of the papers that were read, those who were scheduled to take part in the discussions, and several others. No data are available of the number who took advantage of the opportunity to snatch a few minutes or hours of restful repose in the arms of Morpheus, but it was probably in the neighborhood of 1,755,566, or thereabouts.

MUCH information of interest is found in the February report of operations in the California oilfields. Production for the entire State was practically the same as in January and averaged about 225,000 barrels per day. Shipments, on the other hand, were considerably greater, so that while stocks were not drawn upon in January, there was a shortage of 25,000 barrels per day in February. Reconstruction in the valley oilfields after the January storms has made rapid progress. Most of the wrecked derricks were replaced by the beginning of March so that the production for that month may reasonably be expected to be practically normal. There is a slow but steady increase in development work with each month, but it seems unlikely that production will be suddenly increased to such an extent as to result in any marked reduction in price of either crude oil or the refined products. In fact, all conditions seem favorable for a further increase in the price of gasoline. This, with the spring season fairly well under way, will be anything but cheerful news to California motorists.

'OVERHEAD EXPENSE' is an important consideration in all engineering work. Failure to make sufficient allowance for it in the planning of new work has wrecked many an enterprise. Similar neglect when making valuation studies has been a source of considerable injustice to public-service corporations. In another column we print a summary of the expenditures of the California State Highway Commission to date. We believe that all fair-minded engineers will agree that the Commission has kept its overhead expense to the minimum consistent with efficiency, and further, that for several reasons, the principal one being the magnitude of the work, it was possible to keep this expense considerably lower than on most construction. It should also be noted that the amount given, 12.59% of the total expenditure, is simply the regular overhead expense, and does not include interest during construction, nor the various items usually grouped under the heard of 'contingencies.' Engineers and others who have had dealings with the various public-service commissions can testify that it is difficult to persuade such commissions to allow anywhere near such an amount for the regular overhead expense, including engineering ,general, legal, and promotion expenses, when a valuation is to be made of a corporation's property, whether for purposes of condemnation or rate-making. When it comes to contingencies, the average commissioner, who probably could not build a chicken-house that would stand up, cannot be convinced that any unforeseen difficulties can arise during the construction of a $100,000,000 power

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system. In this connection it is interesting to note that Mr. Charles E. Elmquist of the Minnesota Railroad and Warehouse Commission in a brief recently presented before the Interstate Commerce Commission has claimed that in determining reproduction cost of a railroad no allowance should be made for interest during construction, and in fact, that the only overhead expense which should be considered at all should be for engineering.

THERE is no denying the fact that the War in Europe has sowed a crop of preparedness in the United States that is producing an occasional tare with the wheat. A bill is about to be presented to Congress authorizing a census of the manufacturing and mineral resources of the United States, with special respect toward the accumulation of data whereby these resources may be harnessed for the good of the Nation in case of war. The work itself is to be carried out under the auspices of the five great National engineering societies. The idea is excellent—the surprise lies in the fact that it has never been done before. There is a splendid opportunity for the engineering fraternity as a whole to submit to such military training as will fit them for responding to their country's need in time of war. Just what form this training ought to take is a matter that remains to be worked out. A call has been issued by Mr. Joseph D. Smedberg, as secretary, for the formation of an engineer corps in the State of California whereby it is hoped to enlist one thousand engineers in an informal organization which may later become a branch of the State militia. In reading over the prospectus, it would appear to us that it is somewhat premature for the State to take the initiative in work of this kind, at least until something definite is known as to what course will be taken by the Federal Government itself. Again, while we have no intention of disparaging the work and value of the State militia, at the same time it must be admitted that for one reason or another it has not been in the past as good and efficient a branch of the service as it might have been. The idea proposed in Mr. Smedberg's general statement of the method of organization, which provides for the selection of officers by ballot is an attempt to perpetuate a really laughable crudity that exists in the State militia. We can see no reason why the good fellow, free spender, good mixer, and all-around popular man, should by reason of these attributes be fit to command a company of engineers or a company of anything else. Promotion, or the selection of officers, should be the result of competitive examination, and superior professional attainments and fitness for the position should be the qualifications in accordance with the custom that now obtains in the regular army. It seems to us a practical impossibility to blend the easy-going, happy-go-lucky, semi-military system that prevails in the State militia with the rigid discipline and high standards of efficiency maintained by our microscopic but capable regular army. If any real good is going to result from this more or less casual, haphazard talk about preparedness with respect to the formation of a voluntary engineer corps as an adjunct to the regular army, it ought to be managed, controlled, and regulated entirely by the Federal Government.

Regulation of Municipally Owned Utilities

Is there any real reason why the rules governing a man's personal conduct and relations with his fellow men should not be equally applicable to a collection of individuals? In another column we publish a letter by an engineer concerning the recent purchase of the Hihn Water Company by the city of Santa Cruz. Here is an instance where a community was served by two water-systems, one privately owned and the other conducted by the municipality. For many years the municipal system was operated at a loss. This did not seem to be a matter of much moment to most of the voters, upon whom the individual burden of taxation to make up the loss was not heavy. A few large property owners were hopelessly in the minority as far as votes were concerned, and their protests were feeble and unavailing.

Another consequence, however, was the establishment of rates and a competition for patronage than rendered the business of the privately-owned water company unprofitable, due to the same tactics that have been justly condemned so many times when used by a large corporation as a means for eliminating small competitors. Some two years ago, the California Railroad Commission was asked to place a value upon the company's property for condemnation purposes, and decided that $149,000 was a fair price. The company offered to sell its property to the city in order to protect its stockholders against further inroads and set a price of $110,000 on the property. The Santa Cruz city council at first appeared willing to submit the question to the voters, but the public opposed this course so strenuously that the matter was dropped for a time. In the meantime, the situation kept getting worse until, finally, the privately-owned water-company was sold at a price of $56,000, and even this ridiculously small amount was to be paid in installments and without interest.

Here is an excellent opportunity for the exercise of the functions of the Railroad Commission in behalf of a privately-owned corporation that has been mulcted by the public. It is a very poor sort of a rule that does not work both ways. There is no more reason why a commonwealth should be permitted to ruin private business than that private business should be permitted to levy unfair tariffs upon the people. The jurisdiction of the Railroad Commission should be extended to cover just such cases as this, so that a privately-owned utility might have at least a fair chance for its life. A municipality should pay a fair price to an established private utility, this price to be determined by the valuation engineers for the Railroad Commission, before establishing a competing service and spending money on a senseless duplication of effort that represents a hopelessly unscientific economic waste, to say nothing of the fact that it appears to us positively dishonest to pursue such tactics.

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REVIEW OF THE MONTH

WESTERN Pacific Railroad affairs are once more in the limelight. The reorganization plan was proceeding smoothly with hardly a ripple upon the surface, and seemed likely to go through without opposition. This plan involved throwing into the scrap-pile all the old securities excepting only the original issue of $50,000,000 in first-mortgage bonds, and even for these the face value was to be reduced to a point at which there would be at least a reasonable probability that sufficient money could be earned to pay interest. An additional sum of $20,000,000 in cash was to be provided for extensions, betterments, and the purchase of new equipment.

IT will be remembered that interest on the original bond-issue was guaranteed by the Denver & Rio Grande Railroad. The prosecution of this claim was to be deferred, probably until there would be less danger than at present of throwing that railroad into bankruptcy by pressing payment. Almost at the eleventh hour, however, a disturbing element, consisting of a small minority of the bond-holders, put in appearance and insisted upon immediate prosecution of the claim against the Denver & Rio Grande Railroad and, of course, asking for a continuance of the receivership. The entire matter is still in process of adjudication before the courts, with the representatives of both sides vigorously combating each point. While it is admitted that the various questions involved are those of law rather than engineering, it seems a pity that so much legal circumlocution should be employed to retard the rehabilitation of what might become a useful adjunct to the transportation facilities of the West.

THE case of the Western Pacific Railroad is a good example of an enterprise of the type that requires the expenditure of more money in order to save the amount that has already been expended. Recent financial statements are distinctly encouraging, even after making due allowance for excess passenger traffic due to the Exposition period, and also to the increase in freight traffic on account of the closing of the Panama Canal. With a reasonable sum of money judiciously expended for betterments, and more especially for the feeders that have been so sorely needed since the completion of the main line, the enterprise would appear to hold out at least a reasonable promise of success. A prolongation of the receivership would result in a loss of precious time, the saving of which would appear to be sufficient inducement to bring about a reconciliation of the warring factions.

PLANS for eliminating railroad grade-crossings are being considered by the California Railroad Commission. Several hearings have been held in various parts of the State during the past month. No one questions the advantage of grade separation, especially where traffic is even moderately heavy, and we do not believe there would be any serious opposition on the part of the transportation companies, provided that some equitable means could be found of apportioning the cost so that they do not have to bear the entire burden of expense. Apart from the legal aspects of the case, and looking upon it from the viewpoint of fairness, there would appear to be no real reason why the tax-payers of the State as a whole should not bear at least a reasonable proportion of the cost of such work, since the conservation of their own lives and property is at least as important to them as to the railroad companies. A great deal has been accomplished by various societies and organizations under the slogan of 'Safety First.' Warning signals galore have been posted at almost every danger point on the roads. 'Stop, look, and listen' should be indelibly engraved upon the minds of every motorist. Nevertheless, the daily papers, especially the issues of Monday morning, are replete with instances of the man who did not stop, look, nor listen, and tried to dispute the right of way over a railroad crossing with a locomotive. It appears to be essential that the people should be saved from needless self-destruction in spite of themselves, and grade separation would go a long way toward eliminating one fruitful cause of loss of life.

IN this issue we print an article by Mr. Charles F. Stern of the California State Highway Commission, giving particulars of the successful use of convict labor for constructing a portion of the State highway-system. In other States the propriety of using convict labor for work of this kind has been the storm-centre about which has raged a furious debate. The trade unions and highway contractors are vehemently opposed to convict labor, for the reason that, as they state, it brings into direct competition the convicted felon and free labor. On the other hand, the question naturally arises as to whether the unfortunate denizens of our penitentiaries are not entitled to some humanitarian consideration. Their lives within the prison walls are far from rose-colored. Nor is there any reason why the convict should be petted and pampered. It is a serious problem to provide employment for these involuntary guests of the State and no one, be he criminologist or layman, can question the vital necessity for keeping these unfortunates occupied at some form of industry. The people of the State of California, speaking in generalities, want a State high-

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way-system that will be, when completed, about 2250 miles in aggregate length. With the money thus far expended and the proposed addition of $15,000,000, they will still fall far short of providing sufficient funds to complete the system and maintain the standard of construction followed in the work thus far completed.

THERE seems to be little room for doubt that, insofar as the mountainous and thinly-populated sections of the State are concerned, the Commission will be so short of funds that it will be a case of either convict-built highways or none at all. It is difficult to arrive at a conclusion on so complex a subject, but we are inclined to doubt whether the competition with free labor, in the case of the mountain laterals, will be as great as would appear on the surface. The work done in Mendocino county has proved that convict labor may be successfully employed in a rough country where much hand-labor is necessitated, and where a large number of men can be spread out along the work. It is also true that the country in question is very sparsely settled and offers little inducement to the man who might attempt to escape. In the more thickly settled regions, the use of convict labor is decidedly undesirable, if for no other reason than because of the depressing effect afforded by the spectacle of a chain-gang at work. It is not likely that the Highway Commission will try to find or develop skilled convict labor, such as concrete men, steam-shovel operators, or the like, on portions of the highways requiring such labor. Such work will in all probability continue to be let by contract. We commend a careful reading of Mr. Stern's article as a first aid toward a clearer understanding of the situation.

THE Rittman process of oil refining has advanced beyond the experimental stage to a commercial proposition. Hitherto we have had weird tales in the daily press, and cautious statements from the Government engineers, who in effect stated that they thought they had discovered something remarkable, but could not tell just what it would do. However, Bulletin No. 114 of the Bureau of Mines, which has just appeared, tells definitely the important facts that have already been discovered with reference to the process. As most of our readers know, the process is a 'cracking' one where oils are distilled at high temperatures and pressures. The benzene-toluene process has been brought to a commercial basis in conjunction with the Aetna Explosives Company. The commercial aspects of the gasoline process have not been investigated so thoroughly, but sufficient work has been done to enable the engineers to make some definite statements as to its practicability. Best results in the gasoline process are to be obtained with a temperature between 500° and 575° C. and a pressure of 250 to 300 pounds per square inch. From 25% to 30% of gasoline may be obtained from most oils with each run, and the residuum run again until 80 to 90% of gasoline may be obtained in three or four runs. The remainder is composed of fixed gases and a little carbon. A plant producing 12,000 gallons of gasoline per day would probably cost about $300,000. Best results in the benzene-toluene process are obtained with temperatures between 600° and 750° C. and a pressure of 150 pounds. From 45 to 60% of the original oil is turned to fixed gases. From 3 to 5% becomes carbon. About 10% of the original oil is recovered as creosote oil and pitch. The remainder is divided between benzene, toluene, xylenes, and gasoline. Benzene, toluene, and the xylenes are used in the manufacture of aniline dyes, which the United States has so woefully lacked since the War cut off importations from Germany. Toluene is used in the manufacture of high explosives. The Rittman process has been patented for the protection of the public, with control vested in the Secretary of the Interior, who is thus in a position to make arrangements for its use by the public. The Independent Producers' Agency of California now has the matter under consideration.

THE inadequacy of the present laws governing reclamation by irrigation is exemplified by the present situation in the Victor valley, in southern California. Preliminary plans for the irrigation of 50,000 acres have been prepared and settlers are waiting anxiously for their consummation in order to develop their lands. However, one essential is lacking, namely, funds. The Reclamation Service program is more than filled for many years to come, so nothing can be expected from that source. As a pre-requisite to the formation of an irrigation district and the issuing of bonds, the settlers must own their lands, and in order to own their lands they must develop water and cultivate not less than one-eighth of their holdings. Thus is presented a situation whereby the settlers can neither go back nor forward and, pending the arrival of some financial angel, are situated between His Satanic Majesty and the deep blue sea. It has been suggested that a way out of the difficulty would be to ask Congress to set aside, temporarily, the usual regulations and confer upon the Land Office the authority to grant patents to the settlers without insisting upon the development of water. This idea is of doubtful merit and, if established as a precedent, would be apt to encourage speculation and possibly fraud. Here, however, lies an excellent opportunity to test the plan proposed by Mr. Myron T. Herrick before the International Irrigation Congress last September—permit the formation of an irrigation district embracing the irrigable lands in the valley and obtain a guarantee of the securities from the Federal Government. The bond issue should be for a long period and, of course, constitute a first lien upon the land. These bonds, backed by the Government guarantee, should be marketable at a comparatively low rate of interest. The sum to be realized by the proposed bond issue should be sufficient not only to construct the necessary irrigation works, but also to provide additional capital for the purpose of financing the settlers in improving the property. As the amortization of the bonds takes place, provision could be made for a gradual assumption of the control of the district by the settlers themselves.

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DISCUSSION

Need for Regulation of Municipally-Owned Utilities

The Editor:

Sir—Not long ago it was generally believed throughout California that all public utilities were growing rich by the collection of unjust rates. This idea flourished even where a city held the power to fix rates annually. With the assumption by the State Railroad Commission of jurisdiction over the utilities of the State, there has been a general awakening to the fact that many utilities were really run on a philanthropic basis. This is especially true in districts where an exhaustive study of the affairs of the utilities has proved that they were operating at a loss and that higher rates were necessary if the companies were to continue to exist. Outside of those who have made a special study of the subject, few people realize that the public served and the utility giving service have a common interest. That the public owes a positive duty to the utility and should protect it in its investment is beyond the comprehension of the layman.

This is well illustrated by the recent purchase of the Hihn water system by the city of Santa Cruz, which is the outcome of negotiations that have dragged on for years. The final negotiations were begun about two years ago. At that time the city confronted a water shortage, due to two years of unusually light rainfall. Investigations were made looking to an increase in the water supply. The Hihn company then proposed to sell its entire system and water rights to the city, and suggested that the Railroad Commission be called upon to fix the price. The Hihn company agreed, however, to accept $150,000 as a maximum price in the event that the Commission fixed one in excess of that amount. The Railroad Commission fixed a value of $149,764, made up as follows:

Physical system	$124,614
Water rights	25,150

Following the appraisal by the Commission, preliminary steps were taken to call a special bond election, and the date was set for November 12, 1915. This election was never held. The price finally offered by the city and accepted by the company was $56,000. The terms of payment were $2000 and $600 each month thereafter, without interest, until the total amount of $56,000 was paid.

In the *Santa Cruz Sentinel* for March 19 there appeared an editorial which sums up the transaction very candidly. It says:

"We believe that the city council has made an excellent bargain for the poeple and we congratulate the mayor and commissioners for their service to the public in the matter. As conditions existed the Hihn plant was certainly worth no more to the Hihn estate, but to the city of Santa Cruz we believe its value to be much higher than the amount paid.* * * Figuring the cost of the Liddell spring at $38,300 and comparing its flow with that of the Hihn system, the value of the Hihn system (meaning here the water rights only), would be $151,600. * * * We believe the bargain agreed upon yesterday was the best one ever made by the city."

The writer believes there is no one who will doubt that the purchase for $56,000 of a utility system that the State Railroad Commission had appraised at $149,764, is a bargain. The real difference in the purchase price and the appraised value is greater than the above figures indicate. The present worth of $56,000, under the agreement above, is about $46,000, based on interest at 5%. This is a little less than 31% of the appraised value.

Some may wonder why the company would accept such terms. The reason is simple. Santa Cruz has a municipal system and sells water at a low rate. A municipal plant is seldom operated on a business basis. Depreciation is practically unrecognized. If there is a deficit, it can be made up from the general fund. If there are extensive replacements to be made, bonds can be sold. The general fund is replenished through taxation. The municipal system pays no taxes, but a competitive private company does. The result is disastrous. The private utility, which is forced to operate at a loss in order to meet the rates of the municipal system, is taxed to help meet the deficit of the municipal plant.

In 1912 the *San Francisco Chronicle* made extensive studies of the municipally operated utilities of the State. In that study Mr. Charles Remington says of the Santa Cruz system:

"If given access to the books of Santa Cruz, which has been refused thus far, I will undertake to demonstrate that the city's losses by reason of the operation of its municipal water system, have been more than $60,000 a year for the last twenty-three years."

Whether Mr. Remington could or could not prove the above loss to be as great as that estimated is immaterial. It is sufficient to know that had the municipal system depended upon its water system to be self-supporting, the rates would have been high enough so that its competitor, which was on the ground first, would be independent today and would not be willing to sell out for 31% of the appraised value.

The Santa Cruz case is not an unusual one. There are many municipalities in California which have paralleled the mains of private companies while refusing to purchase the private system, even though they were approached with offers that were more than fair to the city. Not long ago a bond issue for a municipal water system was proposed in Red Bluff, although the pri-

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vately-owned company agreed to sell at a price below the duplication cost of the system. The city of Madera installed a municipal water system. The Madera Water Works endeavored to get an injunction restraining the city from paralleling its mains, but was unsuccessful. The judge, in rendering his decision, commented upon the case, saying in substance that the city, in granting a franchise to the company, by withholding the power to fix the rates annually, had in reality granted a monopoly and should protect the company, but since no contract had been entered into to that effect, the decision of whether or not the city would become a competitor depended upon the sense of justice of the people.

The laws of California give the State Railroad Commission power to fix rates over all privately-owned utilities, but grant it no jurisdiction over municipal systems. No private company can enter the field of another private utility without first getting a certificate of public convenience and necessity. There is no such restriction upon municipalities. The Railroad Commission is helpless to protect the utility against such competition. Even the courts are of no avail. The utilities of this State are operating today under conditions that are extremely hazardous. The Railroad Commission can restrict their earnings to a pittance above operation, but it is helpless to protect them in a case such as the one above cited. The Commission should have jurisdiction over municipally-operated plants as well as privately-operated ones. At present, its power is one-sided. It can give absolute protection only to the consumer. This should be extended to give protection to the utility as well. It is to be hoped that the Legislature will correct this condition by an amendment to the Public Utility Act.

GALE S. STROUT.

San Francisco, March 23.

Measurement Methods in Open-Cut Work

The Editor:

Sir—Mr. Galbraith's article on 'Measurement Methods' calls attention to the great convenience of the use of transit, tape, and rod in measuring irregular earth and rock-work. It has occurred to me that an adaptation of this method which was used by several of us a few years ago, might be of interest to some of the readers of WESTERN ENGINEERING. On railroad construction, when preparing partial estimates, it robbed the end of the month of most of its horrors. The work was in a mountainous country with heavy side-hill cuts and some tunnels. The rock was either quartzite or shale, and had been subject to much folding and faulting. As a result, while in some cases no trouble was experienced in holding a $\frac{1}{4}:1$ slope, in others even a $1:1$ slope could not be maintained. Before grading commenced, the work was cross-sectioned with level and rod in the usual way, but readings on each side were taken well beyond the expected slopes.

The notes at each station and 'plus' were then plotted on cross-section paper. Ten feet to the inch is a convenient scale. When progress measurements are to be made, the transit is used and the notes plotted on the cross-section paper with a protractor. This usually gives an irregular polygon to figure. The geometrical method of finding a triangle whose area is equivalent to that of a given polygon is so well known that it is unnecessary to describe it here. However, it is surprising how quickly the areas may be computed after one has become accustomed to the method. The accuracy of the results of course depends on the care taken. To investigate this, we plotted regular cross-section notes for about half a mile of line in unusually rough country and computed the areas both arithmetically and geometrically and then the volumes. The total volume by the geometrical method agreed with that by the arithmetical method within less than 1%, and at no time did the partial sums differ by more than 2%. I think anyone who has had experience on earthwork will agree that this is fully as close as is practicable. The prismoidal correction may be used in the same way as with the arithmetical method.

In fact there is no reason against using the geometrical method for the final estimate except that the notes would probably not be acceptable in court in case of a suit. The same consideration applies regarding the use of transit and vertical angle in obtaining the original cross-section notes. Where the work is not done by contract, it would often save both field and office-work and be just as satisfactory, to take the notes with the transit and compute them geometrically.

A. T. PARSONS.

San Francisco, December 28, 1915.

PROPOSED ENGINEER CORPS FOR CALIFORNIA

The organization of a Corps of Engineers from California engineers in private life is being undertaken with the co-operation of officers of the U. S. Army and of the National Guard of California. Companies are to be formed in San Francisco, Los Angeles, Oakland, and Sacramento, and the work will be extended to the smaller cities of the State should the interest be sufficient to warrant it. The training is to be by means of personal and group study of prescribed text-books, small squad formation, infantry drill, and annual maneuvers by the entire Corps. It is probable that the organization will eventually become an arm of the National Guard of California. For the present, at least, there will be no fixed term of enrollment, and members will be able to resign on short notice. The organizing secretary is Joseph D. Smedberg, 5558 Taft avenue, Oakland.

Establishment of engineering experiment stations in the different States is proposed in a bill recently introduced into Congress by Senator Francis M. Newlands of Nevada. Such stations would be under the direction of the various 'land-grant colleges' and would correspond in other ways to the agricultural experiment stations already in existence.

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California State Highways*

By CHARLES F. STERN†

There seems to be a widespread feeling that public work means wasteful work; that State administration of a job such as this must needs be inefficient and expensive. Add to this the fact that we have not learned to take our roads and our politics in separate doses. I do not attempt to speak for public work in general; but for the work which lies under my hand I do speak with authority, and frankly challenge any similar project, whether private, corporate, or public to show an administration at once as comprehensive and as economical as ours. The facts, which of course never hamper our critics, I place in evidence. They are absolutely conclusive.

Our activities are far reaching. We operate a purchasing department and supply all materials that go into our roads. It is expensive, but it insures honest materials at a bottom price. In a single month last fall this department purchased and distributed 4750 cars of materials, or nearly 200 cars per working day.

We do our own accounting, disbursing, and auditing, an expense that pays dividends. Our system of inspection and of resident engineers on every job is unusual and expensive. It is the largest item in our 'overhead' cost, but it insures honest work and takes up the slack usually allowed for inferior construction. The initial expense on any part of the work is 100% 'overhead.' Surveys and drafting, plans, etc., must precede construction. This expense is gradually absorbed by construction costs.

A balance sheet of recent date shows an expenditure of $13,746,396, distributed over 1320 miles of road. The cost of administration, technically known as overhead, including purchasing, accounting, and disbursing the expenses of the Highway Commission (the salary of the highway engineer and of the Commission are not paid from the bond issue, but from the general State funds) its attorney and secretary, the highway engineer and his assistants both at headquarters and in the seven divisions, the clerical force, including salaries, expense accounts, rentals, etc., amounts to $604,926 or 4.41% of the total amount expended. Now overhead may be variously defined and limited. To find a definition sufficiently broad to satisfy the most captious, let us include as 'gross overhead' every dollar that did not find its way into the road itself in progress estimates and materials.

Thus analyzed $11,591,188 or 84.32% of the total expenditure went directly into the roads, on contracts let under keen competition and materials bought at 'rock-bottom' prices. The remaining 15.68% represents cost of inspection most of which would be borne by the contractor under the ordinary system, surveys and drafting of the 1320 miles under construction, surveys and drafting of 850 miles in advance of construction, and materials and equipment on hand. Eliminating the last two items, the gross 'overhead' for building 1320 miles of road is 12.59%. In other words, in the expenditure of about two-thirds of the bond issue money, the 'gross overhead' has been reduced from 100% to 12.59%. Included here also is the cost of planning and inspecting construction of many county bridges to become part of the State highway, the expense of practically financing our own work by the sale of $16,500,000 depreciated highway bonds at par, and expensive but needed aid to counties striving for better roads.

Two years ago I undertook a statewide campaign of education, paving the way for the use of convict labor for highway work. In these days of hysterical penology and sob-sister criminology, when professional ex-convicts are capitalizing and exploiting their shame from pulpit, press, and platform, a sane man approaches the subject with reluctance, but I saw a great State need, and a means to meet that need partially.

On the one hand was our mountain-road problem in California. To the east and north-east of us lies a string of counties in and beyond the Sierras. They are loyal Californians, but for months they are shut off from the rest of the State by snow-blocked mountain passes, month after month when there is no mail connection, no fresh meat in camp, no possibility of outside medical attention. And this is the region that should be made the pleasure ground of the nation and a tremendous financial asset to California. The mountain-road needs of California have always been far in excess of her resources and for years to come this must be so. The last legislature was asked for over two million dollars for needed roads, and had not a dollar to give.

On the other hand, behind the walls of Folsom and San Quentin are four thousand men, outcasts from society, hopeless, a burden to the State. If you would study them as I have, you would be struck, as I was, by their appalling youth. This penal problem is a problem of young men, men who have the greater part of their lives still to live as increasing assets or liabilities to their State. The average age of the prisoner is under 30; taken in multiples of five, 25 years would include the greatest number. Of eight men awaiting the gallows a few months ago, the oldest was 33, the next 27, one was under 18, and their average age was under 23.

It seemed to me that if this liability of the State

*Extract from address on 'California State Highways' delivered before the Commonwealth Club of San Francisco, February 26, 1916.

†State Highway Commissioner, Forum Bdg., Sacramento, California.

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could be made a resource, to the benefit of both parties in interest, the convict and the State, a great good could be accomplished. I drafted a bill, simple but comprehensive. It was introduced into the last legislature by B. B. Meek of Oroville. We met every character of objection, fairly and without subterfuge. To the plea that we were going to take a job from a free man to give it to a convict, we answered that we proposed to do work whose character and situation was such that otherwise it could not be done at all. Our bill became a law. It provides for dual control; the Board of Prison Directors directing the discipline and control of the men, the Highway Department supplying everything and directing the work. Close working harmony and co-operation between these departments of the State have made possible the results achieved.

In September we opened our first camp, going slowly on a 'safety-first' basis. We started with 30 men, and have gradually added another 100. They are carefully selected by the Board of Prison Directors, both for trustworthiness and for physical fitness. We house them in sanitary camps, clothe and feed them as we would free men, grant them as much personal freedom as they will not abuse. They work practically on an "honor" basis, being handled by three men without arms in each camp of 60, one guard acting as captain of the camp and the other two as sub-foremen on the work.

No man, be he free man or convict, works without incentive. To these men we give better living and working conditions, practical freedom, and the crowning incentive of one day's reduction in sentence for every two days of loyal and efficient work.

The scheme is working beyond my fondest hopes. We are taking men soft from prison life, many of them never used to manual labor. We are supplying them with everything at the expense of the work, and working them under bitter weather-conditions. Our costs to date are 20% under the lowest estimate, and 50% under what we have paid contractors for similar work in the same region.

Four men have tried to get away. They all claimed they were lost. All were easily recaptured, two by the other convicts. Only the intervention of the guards saved these from summary punishment by their fellows for endangering a scheme which means so much to the men. The men are improved mentally and physically by the open air life and work. In a word, we are successfully turning a State expense of $0.60 per day per man into an asset, not only bettering the man himself but making possible the building of many hundred miles of road that otherwise could not be built.

Costs of reinforced concrete bridges on State highways in Idaho are given in the first biennial report of the State Highway Commission recently issued. These were small bridges from 4 to 12-ft. span of a standard design for a 16-ft. roadway. The contract price of 'dry' concrete ranged from $8.50 to $15.50 per cu. yd., while that of wet concrete ranged from $10.50 to $14.

PETROLEUM AND NATURAL GAS IN REGION NORTH OF SAN FRANCISCO

Occurrences of petroleum and natural gas in Marin, Solano, Mendocino, and Humboldt counties are discussed in bulletins recently issued by the California State Mining Bureau. In Marin county there are several small outcrops of asphaltum along the shoreline cliffs between Duxbury point and Bolinas point. In 1902 two wells were drilled for oil on the mesa back of Duxbury point, apparently without success, although local gossip differs as to whether an oil-showing was obtained, or whether this showing came from oil hauled to the well for fuel.

Near Suisun, in Solano county, is the gas well of the Rochester Oil Co. This well was drilled for oil in 1901 because of a small seepage in the vicinity. Gas was obtained at a depth of 1520 ft. The well was drilled to 1820 ft. but nothing further was obtained. The well produces 20,000 cu. ft. of gas per day, which is distributed by its own pressure to consumers in Suisun, Fairfield, and Cement. No analysis is given. The chemist at the cement works states that the fuel value is good, but that the gas contains considerable moisture. Two other gas wells in the same vicinity are used for domestic purposes only.

There are several oil seepages in the foothills of Colusa county west of Williams. The Williams Oil Co. drilled five wells near Venado post-office between 1905 and 1910. In one of these three feet of sand with oil and gas was struck at a depth of 690 ft. At this point the tools were lost. The deepest of the other wells was drilled to 2560 ft. None of the wells produced either oil or gas in commercial quantities. Other wells in the same region have shown small amounts of gas.

Several wells were drilled for oil in Mendocino county during the years 1865, 1866, and 1867. Oil of an excellent quality was obtained in some of the wells. The quantities obtained, however, were too small to be of commercial importance. There are several deposits of bituminous sandstone, most of them in the vicinity of Point Arena. These contain from 10 to 15% of volatile matter. Efforts have been made to distill the oil, but they have not been commercially profitable.

Some of the earliest oil wells in the State were drilled in the southern part of Humboldt county, beginning in 1865. One well drilled in that year was 500 ft. deep and is said to have produced from 10 to 15 barrels per day. In spite of the fact that supplies and machinery had to be hauled by team from Eureka, a distance of over forty miles, several wells were drilled in the next few years, and operations continued intermittently until as late as 1902. The output was always small, and there has been no production for a number of years. The oil produced is of a paraffin base and has a gravity of about 40° Baumé. The oil produced near Petrolia is dark green, while that from the vicinity of Briceland is reddish. Several of the wells produce a little gas.

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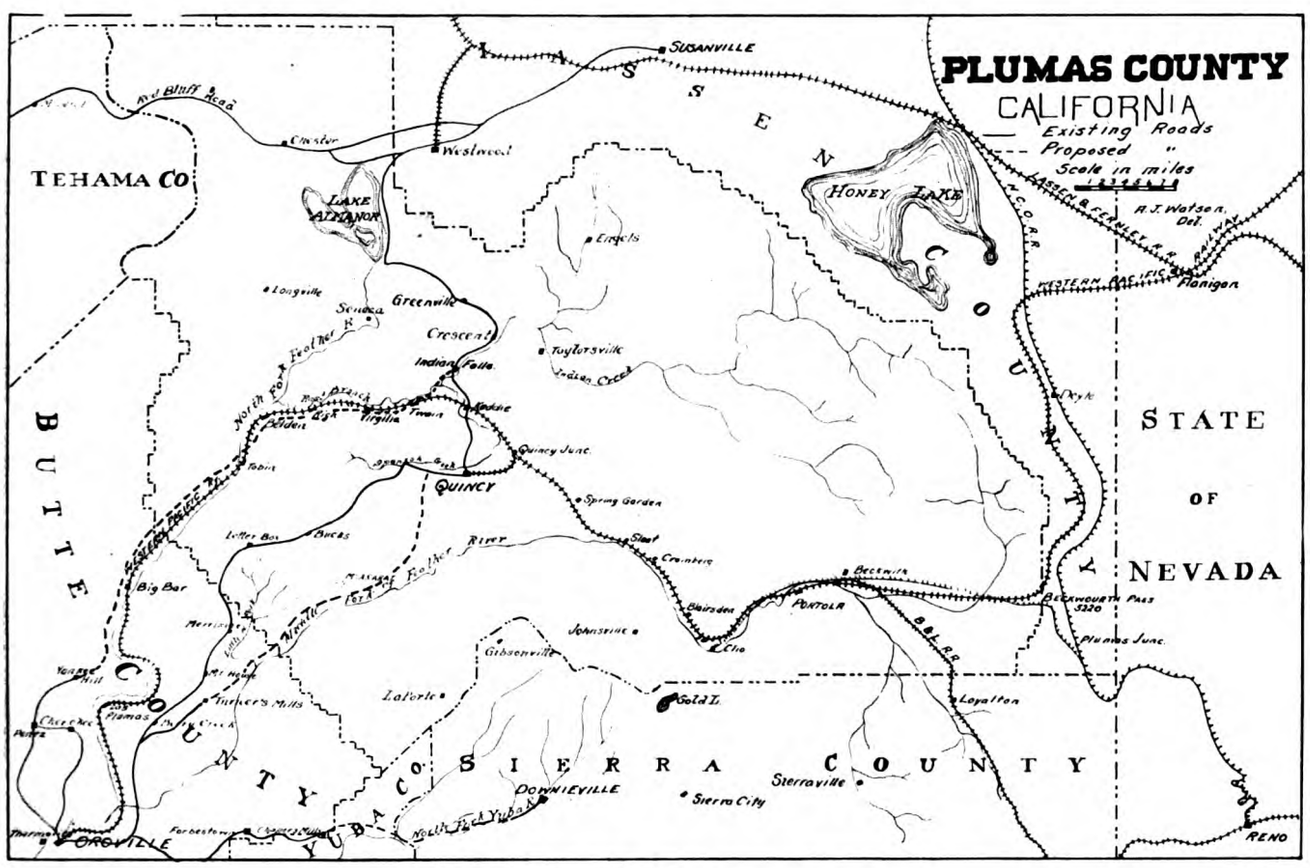
Suggested Routes for the Mountain Laterals of the California State Highway

By WILLIAM WATSON*

The *Sacramento Bee* for March 9, 1916, publishes extracts from a letter to A. M. Saeltzer, president of the Northern California Counties Association from the State Highway Commission outlining the laterals to connect the county-seats of Modoc, Lassen, Plumas, and Sierra counties with the present system of State highways in the Sacramento valley.

What proportion of these roads would have to be changed is not possible to say without surveys. It probably would be about 25%. There is one important objection to the Susanville-Red Bluff road. Nearly two-thirds of its length is as much as 4000 ft., and over twenty-one miles is as much as 5000 ft. above sea-level. The Quincy-Oroville road has over one-third of its



MAP SHOWING EXISTING AND PROPOSED ROADS.

Considering only Lassen, Plumas, and Sierra counties, the proposed laterals are as follows: For Lassen, Susanville to Red Bluff. For Plumas, Quincy to Oroville by the most direct and feasible route. For Sierra, Downieville to Camptonville, thence to a connection with the State highway. The existing roads from the three county seats above mentioned to the Sacramento valley have a combined length of 231.5 miles, as follows:

Susanville to Red Bluff	102.5 miles
Quincy to Oroville	65 "
Downieville to Marysville via Camptonville	64 "

*Civil engineer, Quincy, California.

length above 4000 ft. The Downieville-Marysville road can be built entirely below this elevation.

Assuming that 25% of these roads would have to be changed, we have practically 58 miles of new construction and 173.5 miles of widening and improving. A study of the topographic sheets of the U. S. Geological Survey suggests other ways of connecting these places with the Sacramento valley, which are shown in the accompanying map and approximate profiles.

To connect Susanville with the Sacramento valley two other routes are available. As nearly as can be ascertained from the maps these are about the same length. The first follows the North Fork of the

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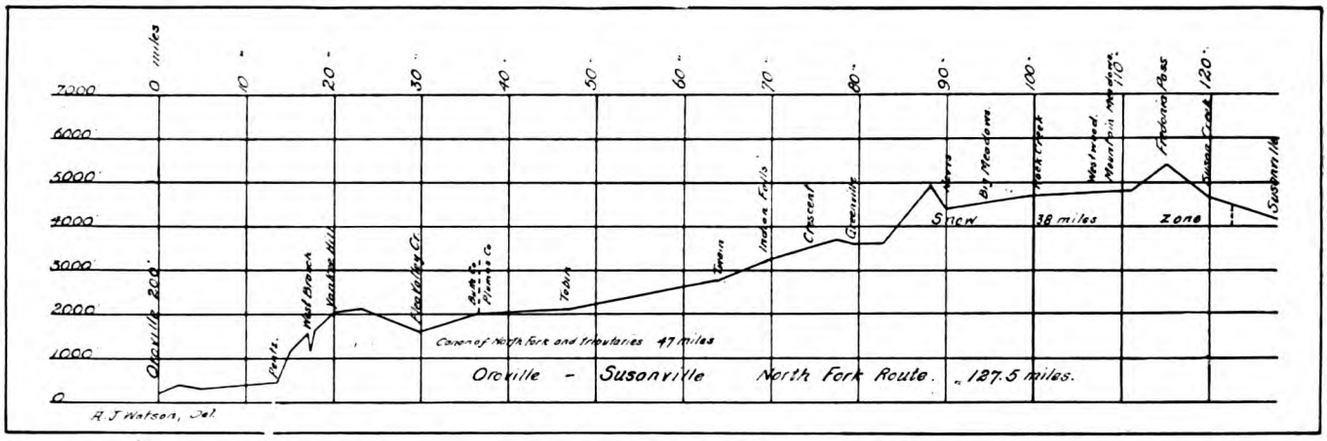


PROFILE OF PROPOSED ROUTE FOR OROVILLE-SUSANVILLE LATERAL VIA NORTH FORK.

Feather river, leaving existing roads at Indian Falls, thence down Indian creek and the North Fork of the Feather river to Flea Valley creek, thence to Yankee Hill, Pentz, and Oroville, a total distance of 127.5 miles. Existing roads connect Quincy and Indian Falls, a distance of 13 miles, making a total of 140.5 miles of road to connect Quincy and Susanville with Sacramento Valley points.

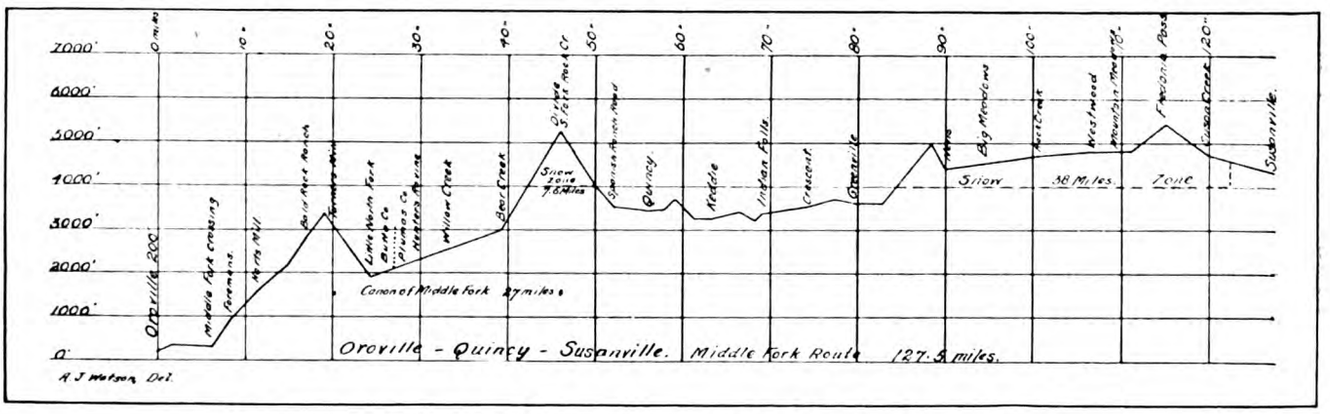
The second follows the Middle Fork of the Feather river. The route is from Susanville to Indian Falls, Indian Falls to Quincy, Quincy to the Middle Fork, thence by way of Turner's Mill to Oroville, requiring 127.5 miles of road to connect both Quincy and Susanville with the State highway in the Sacramento valley.

Comparing the merits of these two routes the second appears to have several advantages. It is thirteen miles shorter, there is but 27 miles in the canyon of the Middle Fork and as far as Quincy is concerned the distance to Oroville is 26 miles less. A disadvantage of this route is the summit at the head of the South Fork of Rock creek, elevation 5260 ft. This, however, is nearly 200 ft. lower than Fredonia pass, 13 miles west of Susanville. New construction on the Middle Fork route would be about 33 miles, and on the North Fork route, 47 miles. On the North Fork route 38 miles and on the Middle Fork route 45.5 miles is 4000 ft. above sea-level.

During the construction of the Western Pacific railway, the Utah Construction Co. built a wagon-road along a large part of the North Fork canyon. However, this road is above the railroad track for a large part of its length and has long been disused. It was built for temporary use and along lines of least resistance. Heavy grades in each direction are frequent. In several extremely difficult places the road has slid away entirely. To reconstruct this road would be about as difficult as to build a new one. The danger to the railroad below would interfere with blasting, and the broken material would have to be hauled to places where it could be dumped.

As has been mentioned already, the serious objection to the Middle Fork route is the summit at the head of the South Fork of Rock creek. At this point there would be 7.5 miles of road lying above the deep-snow line. As half of this distance is on a southerly slope the winter snows melt rapidly, in fact the difference between a north and south slope so far as snow conditions are concerned is fully as much as 1000 ft. in elevation in favor of the latter. That is, at 5000 ft. the snow conditions on a slope facing south are not as bad as the snow conditions on a slope facing north at an elevation of 4000 ft. The snow zone near the summit would therefore be about 4 miles instead of 7.5 miles.

In ordinary years there should be no trouble in having this road open from Oroville to Quincy and Susanville by May 1. In bad seasons it would be about two weeks later. This would be ample time for the usual mountain travel, as there is very little before that date. The existing roads from Susanville and Quincy to the



PROFILE OF PROPOSED ROUTE FOR OROVILLE-SUSANVILLE LATERAL VIA MIDDLE FORK.

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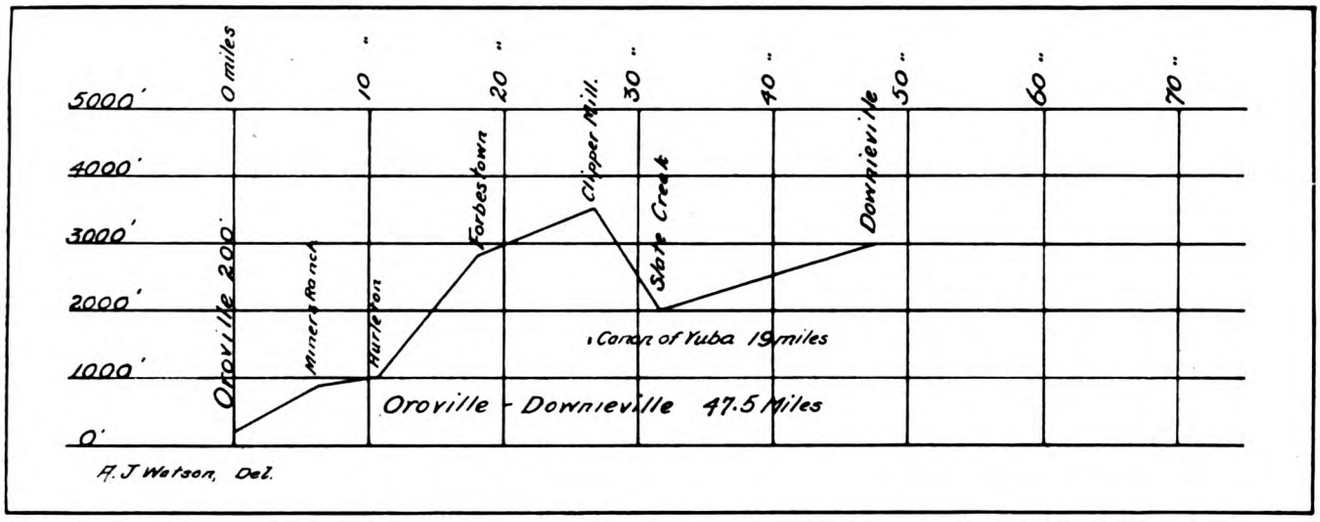


PROFILE OF PROPOSED LATERAL FROM OROVILLE TO DOWNIEVILLE.

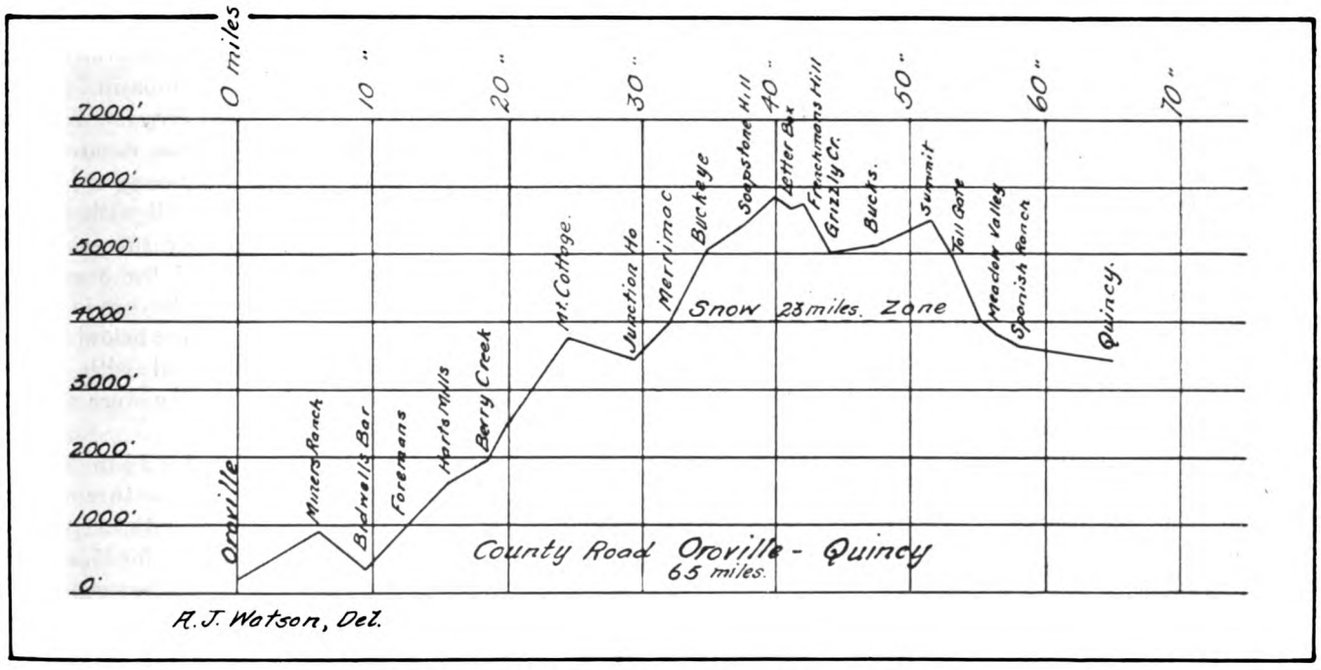
Sacramento valley are not open before June 1, the deep-snow points on these roads being at the summit between Mineral and Morgan on the Susanville-Red Bluff road, and at Letter Box on the Quincy-Oroville road. Fredonia pass is a little lower than the west summit on the Susanville-Red Bluff road and is about 45 miles east of the line of maximum yearly precipitation.

The existing roads from Susanville and Quincy to the valley have a combined length of 167.5 miles, of which 42 miles would in all probability have to be reconstructed. The North Fork route to Susanville and the road from Indian Falls to Quincy have a total length of 140.5 miles, with 47 miles of new construction. The Middle Fork route to Quincy and thence to Susanville has a total length of 127.5 miles with 33 miles of new construction. Where existing roads are used over any of these routes a great deal of work would have to be done in widening and draining. The new work in either canyon would be costly. The yearly maintenance would probably vary almost directly with the mileage, so that in the long run the shortest route would be the cheapest.

The proposed Downieville-Marysville lateral has a length of about 65 miles. A shorter connection can be made by way of Clipper Mills, a distance of 47.5 miles. There would be 19 miles of new construction along the Yuba River canyon.

The total length of the routes suggested above is 175 miles if the Middle Fork route be considered, or 188 miles for the North Fork route, a saving in distance over existing roads in the first case of 56.5 miles, or in the second of 43.5 miles.

The North Fork of the Feather river is traversed by the Western Pacific railway and is easily accessible. Should the Quincy lateral be built by way of the Middle Fork of the Feather river, another canyon with great



PROFILE OF PRESENT HIGHWAY FROM OROVILLE TO QUINCY.

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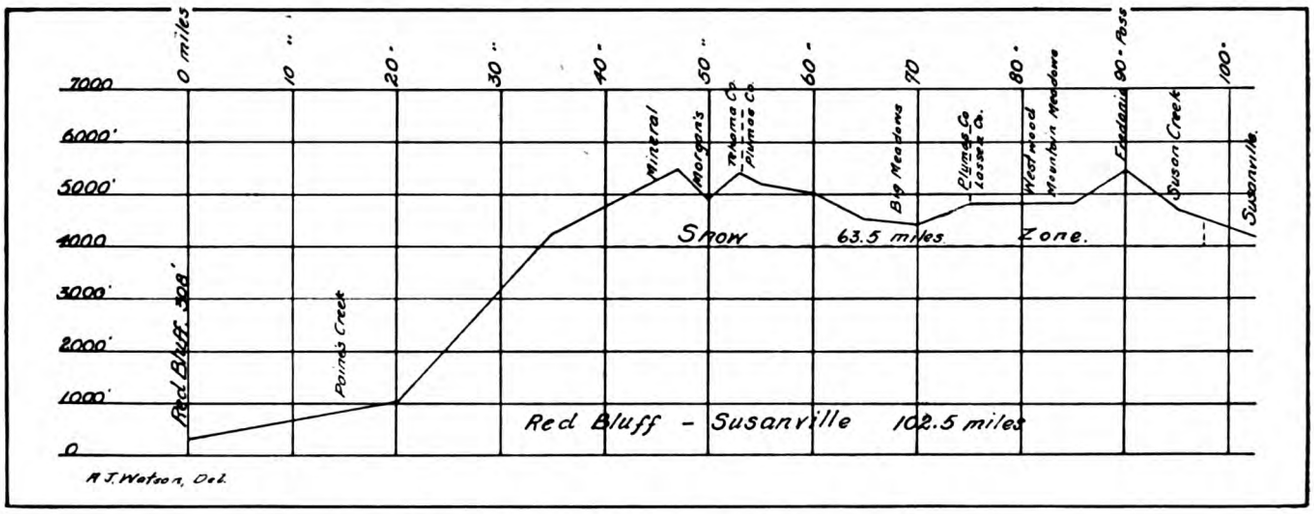

PROFILE OF PRESENT HIGHWAY FROM RED BLUFF TO SUSANVILLE.

scenic beauty would become known. Miles of new fishing streams, besides varied mineral resources would be made accessible. To parallel a railroad with a highway seems like an unnecessary duplication.

The only plausible claim for the North Fork route is that its general elevation from Quincy to Oroville is lower. From Susanville the North Fork route has practically no advantages over the Middle Fork route. From all points east and south of Quincy the distance to Oroville over the Middle Fork route is 26 miles shorter than by the North Fork, and is no longer for points between Quincy and Susanville. From Susanville to the nearest point in the Sacramento valley the Middle Fork route is 25 miles longer than the Red Bluff road, but is shorter from all points in the valley south of Chico, to which city the distance by either route is about the same. The proposed Middle Fork route includes a large part of A. B. Fletcher's suggested Susanville-Quincy-Downieville connection.

Unless financial and other considerations besides those of engineering prevent, I can see no good reason why Oroville is not the best point to begin the laterals for the county-seats of Lassen, Plumas, and Sierra counties, using one common lateral by the Middle Fork of the Feather river to Quincy and thence to Susanville, and one lateral from Oroville to Downieville by way of Clippers Mills. Most of the travel to these counties originates from points south of Red Bluff; likewise the travel from the mountains is to points south of Oroville, principally Sacramento and the Bay cities.

The 'Safety First' movement still has much to accomplish according to a report of the Southern Pacific Company, which states that during the two years ended June 30, 1915, five hundred and twenty-five crossing gates were broken by drivers of vehicles. The chance taken by the drivers is evident. To be broken, the gates had to be down and the gates are down only when trains are approaching. Recently the company had observers stationed at various crossings throughout the State to record the precautions taken by drivers in approaching the tracks. Of 17,021 motor vehicles observed, 11,836 drivers or 69½% looked neither way before crossing the tracks, 2.7% looked one way only, and but 27.8% looked in both directions. On the other hand, 3301 or 19.3% of the total number of drivers ran over the crossings at a reckless rate of speed. Only 35 drivers stopped their machines before crossing the tracks to see that no trains were approaching.

METHODS OF CONSTRUCTION OF ASPHALT PAVEMENT ON OLD WATER-BOUND MACADAM FOUNDATION

The re-surfacing of an old water-bound macadam street with sheet-asphalt is described in *The American City,* by John V. Sprague, of New Haven, Connecticut. About 5000 sq. yd. was laid.

The street was scarified, gutters were cleaned, and blue-stone headers were placed at the cross-streets where necessary. Manholes were raised 3 in. above the contour of the street. In approaching a catch-basin, the macadam, for a distance of from three to five feet from the side as well as the front of the pan, was removed to a depth of 3 in. In some cases it was necessary to take out the macadam to a greater depth, fill with crushed stone, and then tamp until the proper sub-grade was attained. The same method was used for cross-walks wherever they were too high above the grade of the street. All depressions not over 2½ in. below the average contour of the street were filled with binder. Where the depressions were 2½ in., they were filled to grade with crushed stone and rolled.

A 1½-in. binder course was used and a 1½-in. wearing surface. The latter was composed of a mixture of sand, portland-cement filler, and asphalt, with a penetration of 55 at 77°F., under 100 grams for 5 seconds. This work was done in 1913 and has given good satisfaction. The contract price was $1.09 per sq. yd. for the pavement itself and $6.50 per ton for extra binder for filling depressions.

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Earth Roads on Sandy Soils

The improvement and maintenance of earth roads on sandy soils is discussed by Andrew P. Anderson, engineer for the Office of Public Roads and Highway Engineering, in the *Reclamation Record*. The term 'sandy' is used for those soils that are composed largely or entirely of grains of quartz or other hard rock materials, most of which have a diameter not less than $\frac{1}{32}$ or greater than $\frac{1}{4}$ in., and which are nearly or entirely free from clay or other adhesive substances.

Sand is hard and resistant to wear, has a high crushing strength, and is fairly resistant to impact. Its weak point as a road material is its lack of cohesion and binding power. Any means that can be devised to bind the sand grains together will usually provide a good road. The surface tension of capillary water accomplishes this to a certain extent, which explains why a sandy road is nearly always fairly good after a rain. Unfortunately, most sandy soils lose their capillary water so rapidly, especially in arid regions, as to preclude the use of water as an effective agent for improving sand roads.

There are two methods of improving sand roads. The first is to surface the roadway, which is usually too expensive, and is not discussed in the article in question. The second is to incorporate with the sand some material, usually clay, which will bind the sand-grains together or at least decrease their mobility. Grading of sand roads should usually be limited to that required for grade reduction and to provide for absolutely necessary drainage. Dragging such roads, unless they have been treated with clay, or surfaced with some material, does not produce benefits commensurate with the cost. In general a sand road should be let alone as much as possible until a plan of comprehensive improvement is adopted.

The sand-clay road first came into use in the southern States, but the method is also applicable to the arid and semi-arid regions of the West wherever a clay or soil of the required character is obtainable. This type of road is simple in theory. The closely packed hard grains of sand are held in place by the adhesive properties of the clay. Each grain is covered with a thin film of clay and all the voids are completely filled. The ideal theoretical mixture for a sand-clay road is what the mason calls a dense, well-graded mortar. Sometimes materials can be chosen so as to comply closely with the theoretical requirements, while at other times the best possible use must be made of such materials as are available. Sometimes, however, either the sand or the clay may be such that it would be a waste of money and effort to attempt to build sand-clay roads.

The sand must have body enough to sustain the wear of the traffic. Some sands are too fine and rounded to be of much value in road construction. The ideal sand is sharp and coarse, the largest grains about the size of a small pea and graduated in size down to about the size of a pin-head, free from dust and organic matter. But no matter how good the sand, the road will be a failure unless a good clay is used for binder. First of all, the clay must bind or cement well, so that it will hold the grains of sand firmly in place in dry as well as wet weather. A clay that crumbles readily when dry will make a dusty road in dry weather and one that takes up water too rapidly will become muddy in the rainy season. Furthermore, the clay must be stable, that is, it must not expand or contract greatly with varying amounts of moisture. If it does not conform to these requirements it will not make the most desirable binder, as changes in volume tend to displace the grains of sand and, consequently, destroy the bond.

In actual construction, the question of making tests usually resolves itself into choosing between a few available materials and determining the proportion of clay required to form the best mixture. Rapid and satisfactory field tests are made as follows: From typical samples of each of the available clays, test mixtures, varying by one-half part, are made with the sand so that each clay is represented by a set of mixtures ranging by successive steps from 1 part sand and 3 parts clay to 4 parts sand and 1 part clay. These are worked up with water into a putty-like mass and from each mix two equal quantities are taken and rolled between the palms of the hands into reasonably true spheres, labeled and placed in the sun to dry.

When thoroughly baked, a set of spheres representing any one clay is placed in a flat pan or dish and enough water poured gently into the pan to cover them, care being taken not to pour the water directly on the samples. Some samples will begin to disintegrate immediately. Those breaking down most slowly contain most nearly the proper proportion of sand and clay for the particular materials. The relative binding power of the various clays may then be determined by comparing the hardness and resistance to abrasion of the various dry samples having the correct proportion of sand and clay as determined by the water-tests.

In construction, the necessary drainage is first provided, and then the most suitable clay obtainable hauled and spread on the road to such a depth as the tests have shown to be necessary to form a road surface eight to ten inches deep. In general this will be about 6 inches at the centre, and tapering toward the sides. In the best sand-clay roads, analysis gives the following proportions: sand about two-thirds, clay one-third. As the purpose of the clay is to fill the voids and coat the grains of sand, six inches of loose, or three inches of compact clay should make a sand-clay surface of the proper mixture between eight and ten inches thick.

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After the clay is spread, it will generally be found advisable to cover it with a little sand, which can be done by means of the road machine or grader. The next step is thorough incorporation of the materials. In this connection it is well to have in mind the process of mixing concrete by hand, where the materials are first mixed dry and then given a second mixing wet. The same holds true, to a large extent, in the construction of sand-clay roads. On the road, however, the mixing proper may be done in a number of ways, and to suit the facilities of the builder. If the work is done just preceding or during the rainy season it may be left entirely to traffic, with frequent shaping by the road grader, or drag, after heavy rains, but this process is hard on traffic and requires a long time. The mixing can be done most efficiently by means of a disc-harrow either during or immediately after a rain, or the water may be added with a sprinkling cart. The first partial mixing may be done dry but the final mixing must be thorough and should be done when the entire road surface is completely saturated with water until a plastic, mortar-like mixture is secured. This should be followed by a final shaping with the road machine and compacting by either a roller or by traffic.

The construction of a sand-clay road is a process rather than a definite operation. Under ordinary field conditions it is impossible to gauge exactly the proportions of the materials in first construction. Therefore, it is necessary to give careful attention to maintenance for a considerable time. Where the road becomes sticky or soft in wet weather, more sand must be added, and where it ravels and becomes dusty in dry weather, more clay must be added. These materials are incorporated by traffic and by the faithful use of the split-log drag after every rain. Unless careful attention is given to those details, even a well constructed sand-clay road will fail to give satisfaction.

Storage of flood-waters in gravel beds is practised in many parts of southern California. On emerging from the mountain canyons to the plains, many of the torrential streams spread out over large gravel 'cones.' During a large part of the year, the entire stream sinks below the surface into the gravel and furnishes a large part of the flow for wells lower down in the valley. Advantage has been taken of these gravel cones for further storage by excavating a system of small channels and settling-basins, which aid in distributing the flood-waters over a large area of the gravel. It is not feasible to spread muddy waters because they clog and retard the settling-basins, which subsequently have to be cleaned. A Water Conservation Association now controls 2640 acres of wash lands on the gravel cone of the Santa Ana river. In the season of 1908-1909, 2500 acre-feet of water was stored, in 1909-1910, 2400, in 1910-1911, 15,000, and in 1911-1912, 9000. The average cost of storage including both labor and interest charges on the investment is 14c. per acre-foot.

CONVENTION OF THE INLAND WATERWAYS ASSOCIATION OF CALIFORNIA

The annual convention of the Inland Waterways Association of California was held in San Francisco, February 21 and 22. In opening the convention, the retiring president, Isidor Jacobs, told of the importance of the improvement of waterways in reducing the costs of transportation. Stephen I. Miller, Jr. of Stanford University, spoke upon the same subject. The water problems of southern California were discussed by John J. Hamilton of Pasadena, and those of northern and central California by Miss M. McGovern of San Francisco. State agencies dealing with water problems were discussed by D. L. Beard of Napa, and Federal agencies by J. B. Lippincott of Los Angeles. The address of C. E. Grunsky on the departmental plan in public work is reprinted in another column. The adoption of the Newlands-Broussard bill was advocated by George H. Maxwell of Los Angeles. Wilson I. Davenny, secretary of the National Rivers and Harbors Congress, spoke of the importance of co-operation between local organizations interested in waterway problems. Resolutions were passed by the Convention favoring the improvement of the Colorado river, protection of Los Angeles harbor from silt, construction of a channel between Los Angeles and Long Beach harbors, the improvement of the Salinas river and Monterey harbor, the improvements of the Napa river, and the continuance of the Sacramento flood-control project, the Convention, however, refusing to take any stand regarding the position of the Sutter by-pass. No other projects were indorsed by the Convention, probably because no others were brought up for consideration. The Newlands-Broussard bill was indorsed, and resolutions were passed favoring the rehabilitation of the American merchant marine. The abolition of riparian rights in California was favored, provided riparian owners who put water to beneficial use were protected.

Use of large aggregate in concrete is recommended by Edward O. Keator, formerly superintendent of construction at the Gatun spillway on the Panama Canal, in a paper quoted in *Cement and Engineering News*. The larger the aggregate the less is the surface area to be covered with cement. Consequently less cement is necessary for a given strength. If concrete is not well mixed, the stone surfaces get their cement from the mortar in immediate contact with the stone only; hence that mortar is weaker than mortar that is nearer the centre of voids. It has been shown by experiment that the larger the aggregate, the denser the concrete. Use of large aggregate reduces crushing expense. As against the theory that large stones weaken concrete it is pointed out that in breaking up concrete, the very spots to avoid are the large stones. The paper suggests as a limit for 8-in. pavement, 6-in. crushed stone or 7-in. gravel. All aggregate should pass through the mixer.

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Small Reinforced Concrete Railroad Structures Built by Unit Method

By SHIRLEY HOUGHTON*

The desirability of having the minor structures of a railroad system of permanent, fireproof construction is evident to railroad engineers. Hardly a month passes that requisitions are not made for a large number of replacements of minor structures on different parts of a railroad system. These are mainly for bunk-houses and section-houses, and are usually because of destruction by fire.

The electric railway systems of the country have wished for a long time for a permanent type of structure to replace the customary wooden shelter-buildings. The most important reasons for this desire are:

1. Wooden shelters are used by tramps for furnishing material for fires.

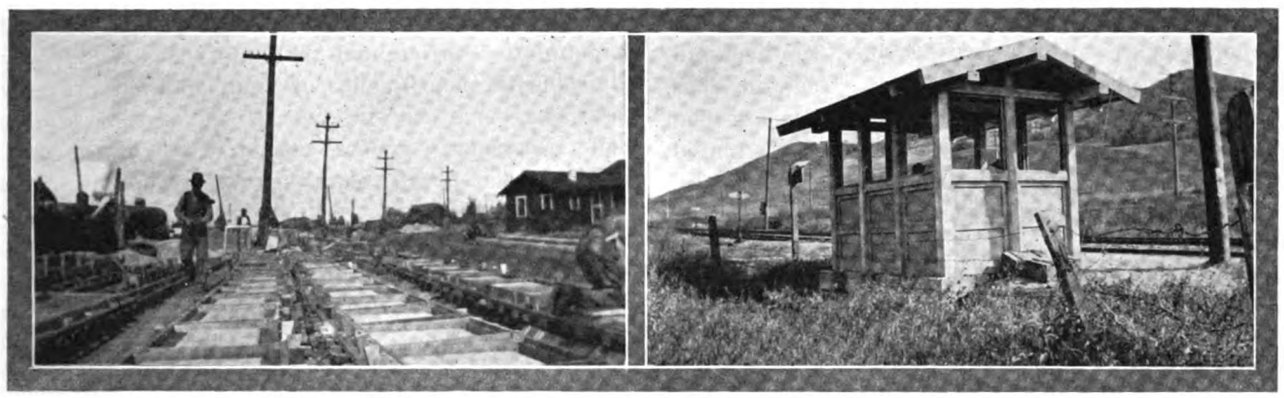
2. Wooden buildings are marked and cut by the ever-ready pocket-knife of the American youth.

3. Wooden buildings are often burned down completely, either through intent or by accident.

The engineers of several electric railway companies considered the shelter-station problem very thoroughly, and decided that brick was too expensive for buildings as small as the general run of these shelters. It was found that the cost of reinforced concrete structures of the monolithic type was also prohibitive, but that concrete buildings constructed by the unit method came within the desired limit of cost. A standard design and estimate was prepared for a Unit-Bilt type of reinforced concrete shelter station, and was found acceptable.

By the Unit-Bilt method, as indicated by the name, the different structural members of a building are cast as separate units in molds or forms firmly bedded on the ground. When these units have hardened sufficiently, they are removed from the forms and placed in a storage yard where they are allowed to season for a period of time varying from one to four weeks, after which they are erected in much the same manner as structural steel. Connections are made between the different units by means of steel bars projecting into the joints embedded in a rich concrete grout. The joints are placed wherever necessary for the structural requirements.

There are many advantages of this method for the erection of such structures. The concentration of all equipment necessary to the work at a casting-yard situated at a central point is important. In this way the units for any number of buildings may be cast on the unit forms, the same forms being used over and over again. When a shelter station is required, the units necessary for the entire building are shipped from the storage yard to the point of erection. As these units are all of what may be called 'man-size,' that is, of such weight and size as to be handled without special equipment, the erection of the structure is simple. A crew of four men can erect a shelter station in approximately four days.



CASTING-YARD FOR UNITS AND COMPLETED STATION.

Shelter stations built for the Pacific Electric Railway Co., in the vicinity of Los Angeles, are approximately 8 ft. 3 in. by 12 ft., with a clear height of 8 ft., the roof of the structure projecting at the sides and ends about 3 ft., giving ample overhang in case of storms. Each building contains approximately 110 units, the weight varying from 400 lb. each for the columns, down to about 33 lb. for the lightest pieces. The completed structure contains about 4¾ cu. yd. of concrete, exclusive of the column footings. On account of variations in grades, these are cast monolithic, the concrete being mixed and placed by hand at the place of erection.

The roof slabs are 2 ft. 6 in. by 2 ft. 2 in. in size, and

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weigh approximately 190 lb. each. They are cast with 1½-in. overlap. When red or other coloring is used in finishing, this gives an appearance of a flat-tile roof. No roofing material is used over these slabs, a waterproofing material being added to the concrete aggregate itself when it is being prepared for casting, and experience has shown that such slabs are watertight. The slabs are finished with a rich mixture containing the waterproofing compound, well worked and hand-troweled to a smooth finish. The slabs are reinforced with standard wire mesh.

The wall slabs which form the exterior of the station are troweled to a smooth straight surface which is then brushed to remove the trowel glaze from the surface. The inner sides are left as they come off the forms, as they are smooth and uniform. All columns, girders, and lintels have one side troweled and brushed. The other three sides are left as they come from the forms, the forms being constructed so that no seams are left in the finished concrete. These members are all reinforced with wire mesh and small deformed bars. The erection of the shelters, after the monolithic footings are completed, is carried on as follows:

The columns are set in sockets provided for them and are grouted in place and well braced. The wall slabs and sills, which fit in the sockets in the columns are then set in place and grouted. The lintels are set and grouted next, followed by the girders, and finally the roof slabs. The shelter is finished by placing concrete benches as follows:

Small unit bents of concrete are set approximately 3 ft. centre to centre around the entire inside of the building, and are connected to the floor and wall slabs. On top of these bents, 2 by 4-in. surfaced lumber is placed and bolted to concrete bents, the heads of the bolts being countersunk. The floor of the station is laid after the units and benches are set.

The units forming the structure are all marked carefully at the time they are removed from the forms so that the erection is simple, the marking of the units being the same as that on the erection plans. Under ordinary conditions the cost of these buildings does not exceed that of wooden structures of the same type by more than 12 to 15 per cent.

About forty of these buildings have been constructed for the Pacific Electric Railway Co., in the territory contiguous to Los Angeles. In the buildings constructed for this company, no provisions were made for heating the stations, as this is not necessary in the southern Californian climate. This could, however, be done simply and conveniently by installing some type of electric heater under the benches. Similar stations have also been built for the Salt Lake & Utah Railway Co., and for the Salt Lake & Ogden Railway Company.

The buildings for the Pacific Electric Railway Co. were designed and constructed by Van-Sant-Houghton Co., of San Francisco, Western representatives of the United Construction Co. of St. Louis, Missouri, under the supervision of E. C. Johnson, assistant chief engineer for the Pacific Electric Railway Co. The work for the Salt Lake & Utah Railway Co. was designed and executed by the same company, under the supervision of W. C. Armstrong, general manager. The work for the Salt Lake & Ogden Railway Co. was also designed and executed by the same company under the supervision of Julian Bamberger, general manager.

[Editor's Note. This is the fourth and last of Mr. Houghton's series of articles on concrete construction by the unit method.]

REPORT ON SEWAGE DISPOSAL IN LOS ANGELES COUNTY

In January of this year the Board of Supervisors of Los Angeles county appointed a Commission of Sanitary Engineers composed of A. H. Koebig, chairman, C. G. Gillespie, A. H. Brosius, C. G. Hyde, and George P. Robinson, to study the sewage disposal problem of the entire county. Its preliminary report has recently been made public. No field work was attempted and only the most general features of the problem considered.

The report calls attention to the fact that the growth of population throughout the county has rendered inadvisable the continuance of many of the sewage-disposal systems in use in several communities, and has made necessary a general consideration of the entire problem. The great area, diversity of population, and variation in population in the district under consideration make a uniform treatment of the problem impossible. Sanitary sewage only is considered, it being considered that the disposal of storm waters is best left to local agencies. With the exception of a few communities adjacent to the Ocean, it is believed that combined sewers are not advisable. The question as to whether or not the sanitary sewers shall discharge into the Ocean or on sewage-farms will have to be decided for each community, as well as the question of preliminary treatment, if any. The Commission recommends that it be allowed a year to make a complete study of the problem, and estimates the cost of such a study at $45,000.

Crowning the grade as a means of preventing pockets and soft places in a railway roadbed is advocated by C. A. Davis in *Railway Engineering and Maintenance of Way*. The present practice of making the grade level straight across before ballasting gives little opportunity for the water that has worked down through the ballast to run off quickly without softening the roadbed. This is particularly true because, as soon as the ties and rails are laid, the middle eight feet of the roadbed has a great weight upon it, while the weight on the remainder of the grade is comparatively small. Where the soil is soft this results in additional settlement at the place where it does the most harm. If the roadbed were to be finished about six inches higher at the centre than at the sides, all this trouble would be avoided and maintenance expense reduced.

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Methods of Construction on Winnipeg Aqueduct

By H. L. TILLEY*

The Greater Winnipeg Water District at Winnipeg, Manitoba, Canada, now has under construction a concrete aqueduct to deliver water from Shoal lake to the city of Winnipeg, a distance of about 90 miles. It is a gravity system calculated to deliver 100,000,000 gallons per 24 hours. The total drop from the lake to Winnipeg is 300 feet. Shoal lake is near the great Lake of the Woods which lies east of Winnipeg and at the United States-Canadian boundary. The Lake of the Woods is fed by streams from the north and inlets from a chain of smaller lakes in the immediate vicinity. Shoal lake has an almost entirely stone shore and a stone or sand bottom and contains water of excellent quality. The present article is based upon my experience during the past season as superintendent for Thomas Kelly & Sons, contractors on contract No. 31.

The greater part of the aqueduct is in a practically level country, ranging from three to eight feet fall per mile. The region being so flat and also underlaid with an almost impervious clay sub-soil has resulted in the formation of swamps and muskeg marshes of considerable extent. Only two streams of consequence, namely, the Brokenhead and Whitemouth rivers are crossed by the aqueduct. Reinforced concrete pressure-pipes have been designed for crossing these streams. One of the crossings is being constructed this winter by enclosing the work and heating with steam-pipe radiators. The other will probably be constructed next winter. On account of the soft, creeping character of the ground, and the amount of water in the streams during the summer season, it is thought to be cheaper to do this work when the ground is frozen to a depth of four or five feet, the cost of housing and heating to prevent the concrete from freezing not being as great as that of handling so much water and mud in the summer season.

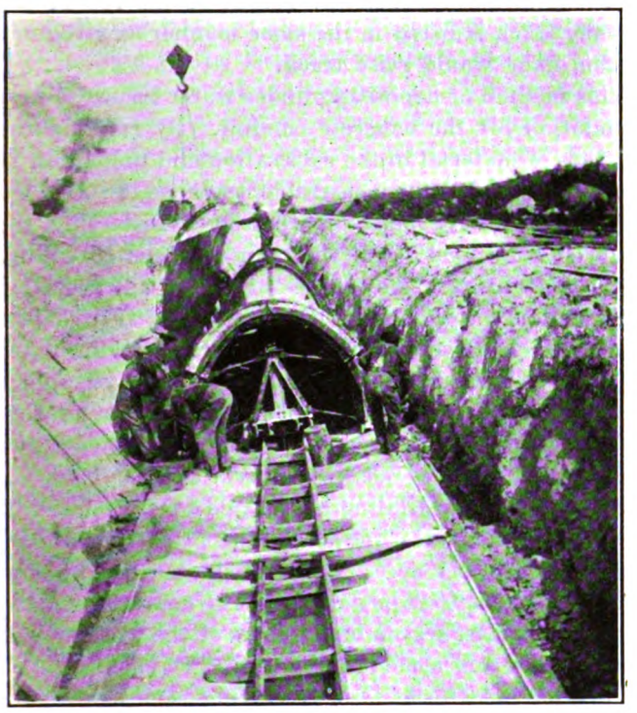

FIG. 1. PLACING FORMS FOR AQUEDUCT.

FIG. 2. PLACING STEEL FOR REINFORCED SECTION.

Most of the conduit is of horse-shoe section as shown in Fig. 1. The dimensions of these sections vary according to the grade of the conduit; the largest is 10 ft. 9 in. by 9 ft. on ground sloping 0.11 ft. per 1000, and the smallest is 6 ft. 4 in. by 5 ft. 5 in. on a grade of 1.53 ft. per 1000. The thickness of the concrete varies with the size of the conduit, ranging from 6 in. at the top and 14 in. at the lower end of the arch to 8 in. at the top and 20 in. at the bottom of the arch. The concrete in the invert is from 6 to 10 in. thick. The conduit is not reinforced except for a few miles on either side of the Brokenhead river, where the pipe is under pressure and for a few hundred feet at other points where there are fills made in deep muskeg, or at road crossings. The reinforced section is round and the reinforcement is

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composed of 1¼-in. square twisted steel bars as shown in Fig. 2.

For a distance of about 30 miles from Winnipeg the aqueduct runs across a sparsely farmed level prairie country with a tough black soil. The only vegetation is grass and small brush. The excavation on this section is mostly three or four feet deep. The contractor on this section is using a walking drag-line excavator with good success. When the concrete conduit is placed in this excavation the top is five to six feet above the general level of the prairie. Frost generally extends about four feet in this country, so back-filling to a depth of about four feet and a half is required. The excavator is used for this purpose after the season's work is completed. Only such excavation as can be concreted and covered before winter is allowed in any one season by the engineers. Some teams are also used for the back-fill. The method of concrete construction as well as the equipment used on this section is practically the same as that employed on contract No. 31, which will be described below. The contractors on the prairie section are Tremalby, McDermott & Co. of Winnipeg. The prices they receive are 29c. to 32c. per cu. yd. for excavation, 75c. for foundation embankment, $6.50 per cu. yd. for concrete in the conduit, and 34c. per lb. for reinforced steel in place. The finished back-fill has to be brought to a smooth surface and seeded to grass; for this the price is $15 per acre.

Before the construction of the aqueduct was undertaken, the Water District completed a standard gauge railroad the entire length of the line, parallel to and 150 feet from the centre line of the aqueduct. This cost about $1,200,000. The road is used for shipping materials and supplies to the several contractors and also for delivery of sand and gravel for concrete.

Many muskeg swamps are crossed by the aqueduct. Muskeg is a sponge-like bed of moss and wiry roots of grass which has developed gradually in thickness through the ages of growth until at some places it is as much as 15 to 18 ft. deep. These muskeg beds are always saturated with water. Sometimes the water stands to a depth of 6 to 12 in. over the surface for a considerable area. The lower portions of these muskeg beds are in a more or less advanced stage of decomposition. One swamp crossed by the aqueduct is a little more than a mile across and the muskeg is from one to five feet deep. The muskeg is first excavated to a firm clay foundation the width of excavation varying according to the depth, but about 35 ft. on an average.

For this excavation a Thew revolving shovel with an extra long boom, specially designed for this work, was used. The shovel will cast a distance of 35 ft. The long reach was necessary because of the width of the excavation and also because the excavated muskeg is slushy and inclined to flow, making it necessary to dump as far as possible away from the bank of the excavation. The shovel is mounted on extra trucks, elevating it about 3 ft. It travels on floats made of 3 by 10-in. planks. Four floats are used, each being about 4 ft. wide by 11 ft. long. Pieces of 40-lb. railroad rail are bolted to the float for the shovel-track. The shovel picks up the floats in the rear, placing them in front and after moving up, repeats the process. Laborers with shovels clear the bottom of the excavation thoroughly to the solid clay. A standard-gauge railroad spur track is then laid in the centre of the excavation for the entire distance, for filling the excavation with sand and gravel to the elevation required for the foundation of the aqueduct. Flat-car loads of the material are carried on this track and the material unloaded in the water. The depth of the water is controlled by pumps, which hold it at such depth as will allow the material to be deposited under water. At the same time the water is not allowed to get so deep that the men cannot work conveniently. When the deposited material has reached the height of the top of the ties the track is lifted in the same manner as a regular section gang would raise track.

This method of depositing under water insures a firm foundation for the concrete conduit. By running the flat cars of material in the excavation and unloading at the place desired, considerable expense is avoided which would have been incurred by transferring the material from bins beside the main line and spreading in the excavation. The contractor rented and installed the track at a total cost of about $700 for the 6000 ft. The District delivers the sand and gravel to the point of unloading at a flat rate of 75c. per cu. yd., place measurement. The contract price for this foundation embankment is $1.50 per cu. yd. For the excavation the contract price is 60c. per cu. yd. and for back-fill, 40c. After the back-filling has settled for a year it will be seeded with grass, for which the price on contract No. 31 is $200 per acre. For the concrete in the conduit the price is $6.25 per cu. yd. The contractor made a good profit last season on all parts of the work except the concrete, and come out about even on that.

Portable platforms for receiving aggregate are placed alongside the railroad and the District unloads the concrete aggregate as required by the contractors at a flat rate of 75c. per cu. yd. Tremalby & Co. on the prairie section and Thomas Kelly & Sons on the Brokenhead section have similar plants, which in a general way are as follows: A specially constructed traveling derrick works midway between the railroad and the aqueduct. A track of ordinary railroad ties and 60 lb. steel rails is laid for the derrick. A steel bottom-dump bucket is loaded with a batch of aggregate and cement at the dump pile and by swinging the boom of the derrick it is delivered to the hopper of the mixer. The mixer plant, which consists of a mixer, boiler, engine, water-tank, pump, etc., is mounted on an ordinary flat-car. A regular standard-gauge railroad track, upon which this mixer flat-car travels, is laid on the bank of the excavated trench. An adjustable steel spout conveys the concrete from the mixer to the steel forms. A drive-chain connects the mixer engine to trucks of the car so that the mixer engineer

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by the shifting of a clutch on his engine can move the mixer back and forth to allow the concrete to be poured at any point desired without the handling of runways or changing of chutes. Blaw collapsible steel forms are used. The inside forms are carried and held in place by a steel traveler. For that purpose a track consisting of 4 by 4-in. ties spaced 5 ft. apart with 20 lb. steel rails is used as shown in Fig. 1.

The concrete invert of the conduit is laid sufficiently far ahead to allow the concrete to get hard enough to support the steel-form carriage and track without injury. These steel forms are handled and erected in 45-ft. sections. The outside forms, which are also handled in 45-ft. sections, are pulled, moved, and set in place by the traveling derrick. Four of these 45-ft. completed sections of steel forms are placed alternately and concreted. When the concrete is set, these sections are pulled and moved ahead. Then steel forms are set for concrete in the four intermediate sections. Steel bulkheads are bolted to each end of the alternate sections as shown in Fig. 1. The outside forms are held at the proper distance from the inside forms by the use of 2 by 2-in. blocks of whatever length is required for the desired concrete thickness. Steel bolts machined to a taper of $\frac{3}{4}$ in. by $\frac{5}{8}$ in. are used for bolting the outside to the inside forms. After the removal of the forms these bolt holes in the concrete are filled with rich grout. The derrick at odd times picks up its own and the mixer track from behind, carries it ahead and places it in front for new work.

The principal trouble with this plant during the past season has been the frequent breaking of the double-flange wheels which carry the derrick. There has also been considerable loss of time in moving the derrick back and forth over the track. This trouble was caused by the soft and spongy ground and the wide gauge of the track which is 35 ft. between rails. This makes it impracticable to keep the rails at the correct gauge. The track sinks several inches as the derrick travels over it, while the lifting power of the spongy ground is sufficient to keep the track in front and behind the wheels at an elevation where it was originally placed. This causes the derrick to be constantly climbing whether it is going backward or forward. The grade is generally such that the traction wheels will skid before they will carry the machine forward. It has been found also that after passing the derrick back and forth a few times over the track, the gauge varies, becoming too narrow at one place and too wide at another. This condition if not detected and remedied before the derrick is moved either turns the rails over or breaks the flanges of the wheels.

To overcome this difficulty I have suggested that a truck similar to those under a railroad flat-car be placed underneath the side of the frame which carries the boiler, hoist, and mast. This would allow the substitution of a two-rail track, instead of one rail, distributing the weight over a considerably greater bearing area. It would also allow both rails to be spiked to the same tie, thus maintaining a correctly gauged track. By substituting manganese-steel single-flange wheels for the present soft double-flanged wheels, the chances for breaks and other delays from bent rails and similar causes would be reduced considerably and possibly the trouble would be eliminated entirely.

The prairie section, contract No. 30, awarded to the Tremalby company, is 20 miles long, extending from mile No. 12 from the City of Winnipeg to mile No. 32. The Brokenhead section, contract No. 31, is 17 miles long and extends from the end of contract No. 30 to mile No. 50. The staff of the Greater Winnipeg Water District consists of James H. Fuertes of New York, consulting engineer; W. G. Chase, chief engineer; M. V. Sauer, assistant chief engineer in charge of designs and C. T. Bruce and R. T. Sailman, division engineers, in charge respectively of contracts No. 30 and 31.

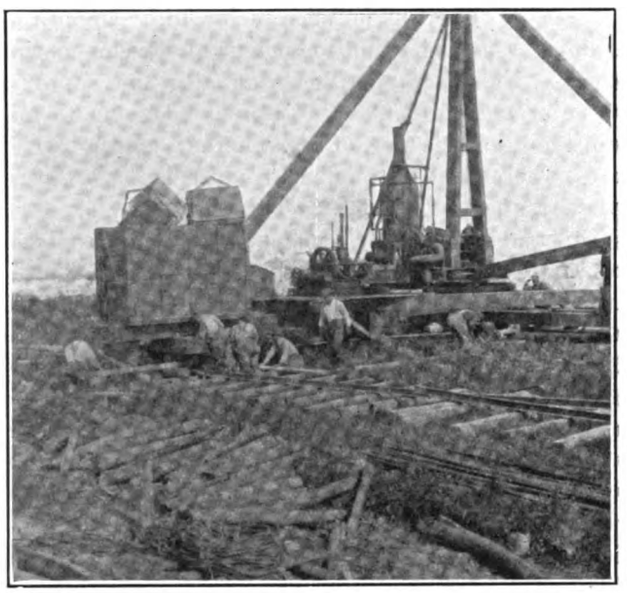

FIG. 3. TRAVELING DERRICK AND TRACK.

[Editor's Note.—Mr. Tilley, who is now connected with the Northern Construction Co., which has been awarded contracts No. 32, 33, and 34, has promised to write an article at some later date upon methods and costs of construction on this part of the work.]

The ductility test for asphaltic cements is discussed by T. L. Crossley in the *Journal of Industrial & Engineering Chemistry*. The usual test is made by pulling apart a briquette with a cross-section of 1 sq. cm. at a rate of 5 cm. per minute. Some machines used for the test are only slightly over a metre in length and there are many asphaltic cements of 60 to 70 penetration which can be pulled over 100 cm. Most specifications call for from 70 to 90 cm. at the rate of 5 cm. per minute, and it is not difficult for a cement to satisfy this test. As a means of getting a more accurate comparison between various cements, a speed of 10 cm. per minute is proposed. It has been found by experiment that the really suitable cements will satisfy this test.

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The Departmental Plan in Public Works*

By C. E. GRUNSKY†

The conservation and use of the water supply of this country is of paramount importance. Water is required to supply the bodily wants of man and beast; it irrigates the farm; it furnishes power, and through power, heat and light; and it affords means of intercommunication. From the fullest development and use of the water-power resources of the country the greatest conservation of the fuel resources, both coal and oil, will result. There is no need of dwelling upon a fact so obvious as the value to society of developed water power. Nature replenishes annually the supply of water at high altitudes. It is true economy to make provision for the use of its inherent power, even in cases where such development must be at a cost in excess of the cost of power generated by steam.

Now and again water is a menace. When our streams are in flood the water rushes from the mountains toward the sea, breaking over broad stretches of cultivated, inhabited sections of the land and destroying life and property. The engineer who is called upon to deal either with the problem of conserving the water supply, of conserving the energy represented by the water as it descends from mountain to valley and to the ocean, or of controlling it when streams are in flood, too often finds himself badly handicapped in the solution of his problems by the lack of adequate data. When he is in need of information that he cannot glean from the stream itself at a moment's notice, where does he turn? To the records of the United States Geological Survey as a matter of course, and nine chances to one he will find there only a small part of the information he needs.

The work which has been done by that Bureau in the past under Major Powell and under his successors, C. D. Walcott and Geo. Otis Smith, cannot be too highly commended. This work which was inaugurated by Major Powell is being continued today, largely with the co-operation of the States; but the attention which it receives is by no means commensurate with the importance of the facts that are to be ascertained. This work will not bear interruption and it can never be completed. The study of stream flow must be carried on far into the future, and the engineer of fifty and one hundred years from now will praise the foresight of those who are today collecting data whose value grows as time passes.

The work which is being done in this direction falls far short of what should be done. The Geological Survey is handicapped for lack of funds. Only about one-third of the 48 States of the Union are at present co-operating with the United States Geological Survey in studying their water resources. Among these California has long taken the lead with contributions as great as $40,000 per year. The funds that are provided by Congress for the stream-flow studies are not commensurate with the importance of the ascertained facts, which are invaluable aids in the basic studies leading to the full economic development of the country's natural resources. To get the pitifully small allowance with which the Water Resources branch of the United States Geological Survey pursues this work, an annual struggle is necessary, and this Congressman or that has to be convinced that stream-flow data really have some value.

This is not as it should be. Why, may properly be asked, is work such as this, or that of the United States Reclamation Service entrusted to scattered departmental bureaus whose existence is precarious? Wisely and well as the affairs of these bureaus have been conducted in the past it still remains true that greater permanence should be given to them. This can be best obtained by merging them and all related bureaus into one great Department of Public Works.

Any student of the science of government will be struck by the lack of inter-relation and lack of co-operation between the various bureaus and other subdivisions of the Federal Government which have been placed in charge of public works, and the preliminary studies and surveys which precede the actual execution of such works. The bureau system has been one of gradual development, a development under which the activity of the several departments of our government when exercised along useful lines was recognized. In the Department of Agriculture, for example, the question of land drainage and the reclamation of swamp-lands has been under study for a number of years. Measures have been suggested for the betterment of areas in various sections of the country under a plan similar to that under which the reclamation of arid lands is made possible by irrigation. What will be more natural, if such swamp-land reclamation is authorized, than to create a bureau within this Department of Agriculture to take charge of this work? Would not this be analogous to the formation of the United States Reclamation Service in 1902 under the Secretary of the Interior? And would not such a procedure conform to established precedent?

The irrigation of the arid lands was under study by the United States Geological Survey for many years, before Congress was convinced of the wisdom of ex-

*Address delivered at the annual convention of the Inland Waterways Association, San Francisco, February 21, 1916.

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tending financial aid and of assuming responsibilities for the construction of works for the irrigation and reclamation of arid public lands. When finally action was taken what could have been more natural than to allow those who had worked so enthusiastically for the principle of Government aid, to take active charge of the Federal irrigation project? This was done and the bureau known as the United States Reclamation Service was the result. The hydrographers of the United States Geological Survey became the engineers of the United States Reclamation Service. Within a few years an important new bureau had been created with a director at its head, and this bureau naturally remained under the Secretary of the Interior, taking rank with the United States Geological Survey, from which it was separated by easy stages.

The United States Geological Survey requires as a basis for its studies of the mineral resources of the country carefully constructed maps. No adequate basic data for these maps existed when the work of the Survey began, and field surveys were necessary to obtain the same. The result was the creation of an efficient staff of topographers whose services to the country have been invaluable. The resulting maps are of paramount importance when water problems and the like are under study and the data which they supply have been and are being supplemented as already explained by the Water Resources branch of the Survey. In what I am about to say relating to the merging into one department of all the bureaus which are concerned with the execution of public works or with the collection of data relating thereto, no reflection upon the conduct of the affairs of this or of any other Government bureau is intended and no criticism of the individual bureau is contemplated.

When in the same year the law was passed by Congress directing the President to undertake the construction of an Isthmian canal, it was found desirable to create new machinery for handling the project. A commission was created, and an organization perfected, which was independent of any of the other bureaus which at that time had charge of public work in one form or another.

More recently the United States has entered upon a physical valuation of the interstate transportation lines of the country. A large staff of engineers has been employed on this work, which will cost the country many millions of dollars. This again is undertaken by an independent bureau not related in any way to any other of the many which deal with the problems that naturally should be handled by a Department of Public Works.

The nearest approach in our scheme of government organization to such a Department is the Engineer Corps of the United States Army. The men trained at West Point who qualify as engineers are, under the Secretary of War, placed in charge of military defenses and of the Nation's river and harbor work. Their record is an enviable one and the magnitude of the enterprises which they direct, involving as they do an aggregate annual expenditure of from $20,000,000 to $50,000,000 entitles the Engineer Corps to first consideration when a Department of Public Works is to be organized.

Our loose methods of managing everything else, relating to the public works of the country, the complete lack of co-ordination, the jealousy of the individual bureaus, with the resulting inefficiency when considered as one big problem, all point in one direction. The question with which the Nation is confronted is not so much whether or not a Department of Public Works is desirable, but in view of the obstacles that will be thrown in the way of its establishment by all the bureaus, which naturally fear curtailment of their spheres of activity, whether or not it is too big a step to take at once.

Personally, basing my opinion on considerable experience, some of which was gained in close contact with members of the Cabinet, I am convinced that if the country in general understood the problem it would not be long before some one of the Cabinet positions were replaced by a Secretary of Public Works. Why not? Why should not the members of the Engineer Corps feel as comfortable, and be able to work as efficiently under a Secretary of Public Works, who probably would be selected from their own ranks or at least from the profession, as they now work under some capable business man or mayhap occasionally under some one whose prime qualifications are to be found in past party services.

We find in the Newlands-Broussard bill now before Congress a recognition of the necessity to meet in some way the demand for more work on rivers and harbors but we can see in it no attempt to create a responsible permanent head. The wisdom of allowing the bureaus to continue as in the past with a multiplicity of heads is seriously to be questioned.

In such a Department of Public Works the employment of the engineering staff in so far as permanent positions are concerned should be for life. The accessions to the staff from West Point should be supplemented from the ranks of the young men of the country who pay for their own technical training at the engineering schools of recognized standing. There should be uniformity of rank regardless of the school at which the engineer was trained, but there would naturally be some distinction in the requirement of military service.

It will not be necessary to go further into detail, beyond indicating some of the bureaus that would naturally be assigned at once to such a department. There have already been mentioned the Engineer Corps of the Army, the Reclamation Service, the Isthmian Canal Commission, the Alaska Railway Commission, the Coast and Geodetic Survey, the Water Resources branch of the Geological Survey. In addition there are the Bureau of Public Resources branch of the Geological Survey, the Bureau of Public Buildings now under the Secretary of the Treasury, the Valuation Bureau of the Interstate Commerce Commission, and no doubt other

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bureaus besides those that are likely to be created to handle swamp-land reclamation and road work. All of such bureaus as are enumerated here belong naturally in a Department of Public Works where their activities would be properly co-ordinated, and where such co-ordination would result in increased efficiency not only on account of lesser cost, but also because of the better results that would follow from the general and definite responsibility that would fall upon such a department.

What has been said about the desirability of a Federal Department of Public Works is applicable to our own State affairs. Within the last few years California has entered upon the construction of a State highway system and is expending upon the same $18,000,000 with a prospect of an additional sum of $15,000,000, which will undoubtedly be voted this fall. The State has also undertaken the direction of the work of flood control. Of the magnitude and importance of this undertaking I need not speak. The growing need of supervising public work in this State was recognized in 1894, when the office of Commissioner of Public Works was created, which was later superseded by the State Engineering Department. The many community enterprises such as the irrigation and reclamation districts are dependent upon credit in order to obtain funds. They need State supervision and are receiving it to a limited extent, though without the assumption of any responsibility by the State. The many State institutions are in constant need of new buildings, waterworks, and sanitary or other improvements. Some of these matters have been placed under the State Engineering Department.

If they could all be united in one Department, this would undoubtedly be to the advantage of the State, and to the advantage of the several undertakings. In making this suggestion I must here also disclaim any intention to criticise unfavorably or otherwise, any of the Commissions or the Department which is at present handling the work at the State's public institutions, but I foresee that this State will have to go further than it has heretofore in the matter of assuming responsibility for the success of many community enterprises such as irrigation and reclamation districts, and that there should exist an adequate State department for taking charge of such work in addition to the public work now handled by Commissions or similar agencies.

Protection of fresh concrete pavement during the construction of the Allentown-Easton, Pennsylvania, highway by the use of canvas is described in *Concrete*. The pavement was 16 ft. wide. A strip of canvas 19 ft. wide and 50 ft. long was rolled around a length of 2-in. pipe. Frames were placed on the shoulder of the road on each side, being supported by steel-strap stakes bent at intervals around 2 by 3-in. runners. Across the road, 2 by 3 in. by 17-ft. sticks were laid resting on the frames on each side and spaced from 12 to 14 ft. apart. The canvas was then unrolled over the frame without dragging in the concrete.

METHODS AND COSTS OF SURFACE FINISHING FOR CONCRETE

A report prepared by a committee appointed by the American Railway Engineering Association to investigate surface finishing of concrete has recently been made public. A number of different methods of finishing are discussed.

Spading, to work the coarse aggregate away from the form and to bring the mortar against it, is the method generally used, particularly in cases where no decorative treatment is required. It is difficult to segregate this cost from the other items entering into the cost of placing concrete, but the additional expense over the ordinary finish is small. The surface is generally smooth and nearly impervious to moisture, and its wearing qualities are equal, if not superior to the finish produced by any other method.

Coating with a wash composed of one part cement and one part sand, applied with a brush, is seldom satisfactory. The film of mortar usually develops a tendency to checking and hair-cracks.

Several methods of finishing by rubbing are in use. One way is to remove the forms as early as practicable, chip off prominent joint-marks, wet the surface and rub it with cement mortar or carborundum brick. The cost of this work is from 4½ to 12c. per sq. ft. Another method is to rub the surface with wooden floats as soon as the forms can be removed. The surface is flushed while rubbing, and washed afterward. This work will cost 3 to 4c. per sq. ft. Rubbed surfaces have a uniform finish and appearance, and do not flake or scale.

The surface may also be finished by removing the outside mortar and exposing the coarse aggregate. This may be done by washing and scrubbing with stiff brushes immediately after the forms have been removed, by treating the surface with dilute nitric or muriatic acid, or by the use of a sand-blast. It is hard to obtain a uniform surface with the sand-blast. Where there is a large amount of work, so that the cost of erecting the plant is not the chief item, finishing with a sand-blast can be done for 2c. per square foot.

Bush-hammering produces an attractive and durable surface. The best results are produced with spaded surfaces or those composed of special aggregate. The cost ranges from ¾ to 2c. per square foot.

Scoring the surface may be accomplished by placing horizontal and vertical V-shaped battens on the inside of the forms. This breaks up the flat appearance.

Metal instead of wooden forms give a much smoother surface, but many engineers prefer the rougher surface and claim that it is really more pleasing to the eye than the smooth surface. In spading concrete against metal forms there is danger of bringing a thin skin of rich mortar next to the concrete. Later this surface is likely to crack and check.

Plastering is done occasionally, but it is expensive. It is also hard to obtain a good finish. Cement-gun work is not mentioned in the report.

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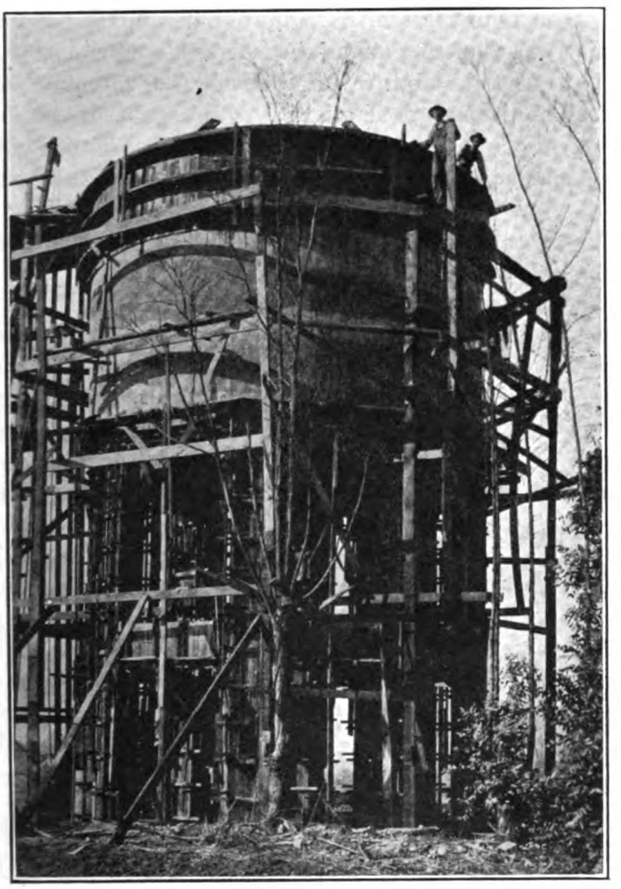
Design and Construction of Elevated Concrete Tanks

By J. ALDEN GRIFFIN*

Until recently, most railroad engineers have been of the opinion that reinforced concrete does not compare favorably with wood or steel as a material for railway water-tanks. Nevertheless the few reinforced concrete elevated tanks and stand-pipes that have been properly designed and constructed, possess several advantages over wood and steel tanks. The time is not far distant when the railroads will make a more general use of the concrete tank.



VIEW OF TANK DURING CONSTRUCTION.

The principal advantages of the concrete tank are its durability combined with practically no maintenance cost, while its principal disadvantages are in its greater first cost and its immovability. It is necessary of course to exercise the utmost care in the design as well as in the selection of the materials, the class of workmen and the mixing and the placing of the concrete in order to get a dense, impervious wall and floor. Naturally this adds to the first cost. However, in places where the tank can be constructed on a permanent site, this increased first cost, which is but little more than that of a steel tank, will be more than counterbalanced by the saving in maintenance as compared with a wood or steel tank. In addition the concrete tank will outlast several of either of the other types.

To prevent cracking from shrinkage in the concrete during setting, it is advisable to run concrete continuously during the placing of the wall of the tank, thus preventing the formation of cracks along construction joints. However, with the proper distribution of the steel and the addition of a small plate dam in the joint, embedded partly in the old and partly in the new work, a joint or stop may be made without danger of cracking.

An objection which is raised by some opponents of concrete for tank purposes, is, that the elasticity of the steel reinforcement, even though it is stressed considerably below the elastic limit, will permit it to stretch sufficiently to crack the concrete. This objection, however, is without foundation, for the successful construction of several tanks of this type has demonstrated that such cracks do not develop when the proper unit stresses are used for the concrete and steel. The use of a moderately low working stress in the steel, say 12,000 lb. per sq. in. and neglecting the tensile strength of the concrete entirely will eliminate the danger of such cracks. This would require the use of practically as much metal as in an all-steel tank except for the fact that a higher unit stress may be used in the rods than in the thin plates owing to the former being protected against corrosion. While this form of construction requires concrete in addition to the steel, the decided advantage of having the steel protected against corrosion and fire, will more than offset the slight difference in cost.

In a properly designed tank where a mechanical bond for the ends of the rods is effected either by lapping say 40 diameters and wiring securely or else hooking the ends of the rods, the thickness of the wall need only be sufficient to prevent percolation and to deliver the stress from the mid-point between the rings to the rings themselves, since no hoop-tension is assumed to be taken up by the concrete. This is similar to the stresses in a wood-stave tank, the separate staves not being expected to take any stress at their joints but simply to span the bands and to transfer the load between the bands to the bands themselves.

In concrete tanks the distance between rods, or the span for the slab, is generally short. This makes the bending moments in the slab so small that the concrete is not materially stressed. For example, assume that the rods of a certain tank are spaced 4 in. centre to centre at a depth of 20 ft. from the water surface. The slab being continuous, the maximum moment is 11 ft. lb. per ft.

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width of slab. Assuming this moment to act upon a slab of the thinnest protective coat, say 2½ in. from face of steel to face of wall and taking no account of the balance of the wall thickness, the stress in the extreme fibres would not exceed 10 lb. per sq. in. When the total thickness of the wall, which should not be less than 5 in., is considered, the stress is practically nothing.

The use of walls less than 5 in. thick for any tank is not recommended. Small rods spaced closely should be used rather than larger rods at a greater distance apart, in order to distribute the steel more uniformly and to minimize the danger of cracking the concrete on account of shrinkage around the large rods. For these reasons it is obvious that the stresses shown in the above example will be seldom if ever exceeded.

A rule for determining the thickness of the concrete wall used by those who advocate allowing the concrete to take a portion of the hoop-tension, is to provide a thickness such that when from the total tension in pounds at the section considered there is subtracted 3000 times the area of steel in sq. in. required at the section, and the stress in the steel limited to 10,000 lb. per sq. in., the remainder will not stress the concrete over 300 lb. per square inch.

Equating this in terms of the depth and diameter of the tank we have, t at any point $= \frac{T_s - 3000\,A_s}{300}$ from whence $t = 0.00612hd$, in which

t = thickness of shell in inches.

T_s = total tension on section considered.

A_s = area of steel in sq. in. required at section considered.

h = depth of tank to section considered.

d = diameter of tank.

This method of design has two decided disadvantages; first, it requires the use of considerably more concrete without materially reducing the amount of steel; second, it subjects the concrete to a tensile stress that increases the danger of cracking.

The question of the best method for waterproofing a tank properly is much debated by the advocates of the several waterproofing compounds, but it is best to settle it by actual experiment. While it is obvious that even the finest and densest mixture will be somewhat porous, if an experienced crew mix and place the concrete this condition will be reduced to a minimum, and with it, the amount of additional waterproofing needed.

For tanks where the concrete is allowed or required to take tensile stress, great care must be taken in the selection of the waterproofing compound, as some of these compounds impair the strength of the cement. Again it is of little use to attempt to waterproof a wall, where the concrete is in tension, since the stretching and shrinking of the wall will crack and chip off the coating.

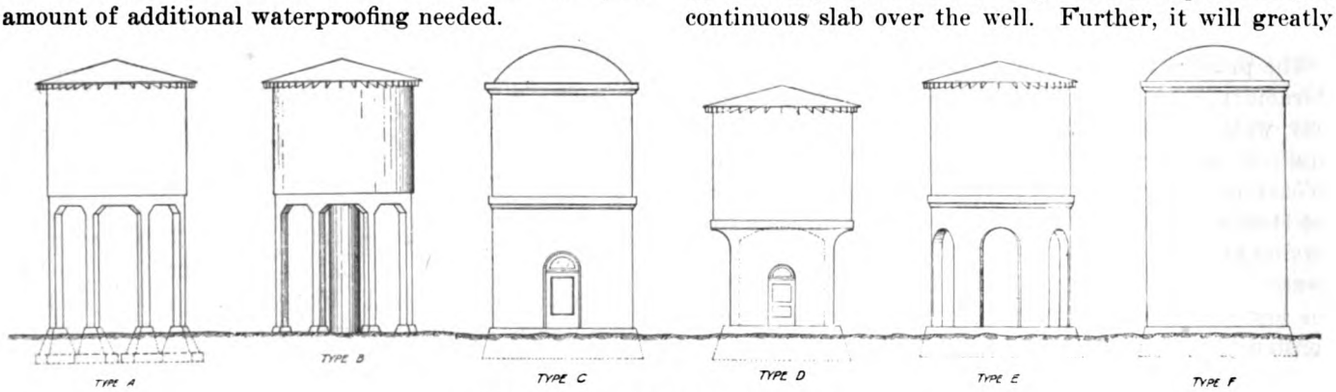
An effective waterproofing mixture has been made from alum and soap combined with hydrated lime. The best proportions are as follows: To the concrete mixture, add hydrated lime up to 5% by weight of the cement used. For mixing-water use a solution of ½ lb. of soap and ¼ lb. of alum per barrel of water. It is best to have several barrels of the solution on hand so as to use only a mixture that has been thoroughly dissolved. This has been found to seal the minute pores in the concrete entirely without impairing the strength of the mortar.

I prefer this mixture for internal waterproofing and as an additional precaution a double coat of Medusa Waterproofing Compound upon completion of the tank. This method of waterproofing has been used with success on a number of tanks and reservoirs, designed by me.

The accompanying sketches illustrate a few economical designs for concrete tanks.

The pumped water often contains sediment. If this is left to settle in the tank it reduces the capacity. Furthermore removal of the sediment is expensive. For such cases, a standpipe having the lower ten or twelve feet reserved for the collection of sediment is often more serviceable and economical than a tank. If it is necessary to raise the water to a considerable height, the additional cost of construction of the lower ten or twelve feet will be large on account of the heavy load of the water above and the use of a tower will prove more economical.

Of the several types of tank shown below, type *A* is the most common and consists of reinforced concrete columns resting on piers where the sub-foundation is hard, or on a reinforced concrete deck-slab where the character of the soil is such that unequal settlement is possible. In places where freezing temperature occurs, type *B*, which is similar to type *A*, except that it has a central well for protecting the supply and discharge pipes, should be used. The central well will serve in place of the interior columns, and will reduce the cost of the tank floor, by allowing the omission of girders and permitting a continuous slab over the well. Further, it will greatly



TYPES OF REINFORCED CONCRETE TANKS.

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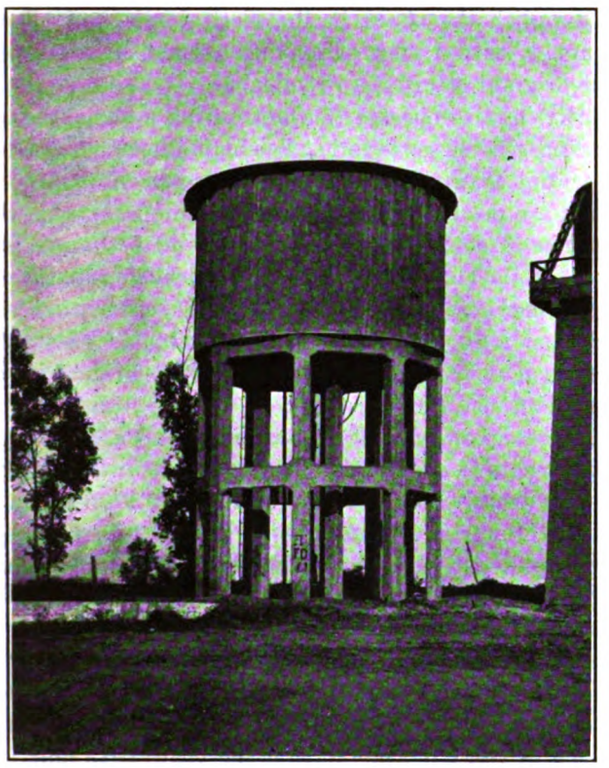
lessen the stress due to wind load in the exterior columns. Types *C* and *D* are serviceable structures, as the enclosed space below the tank may be used as a tool or store-room and at the same time provide protection for the valves and piping. Type *E*, which is a modification of types *A* and *B*, differs therefrom in that, instead of columns, portions of the lower shell are omitted by simply blocking out between the forms. Type *F* is a plain stand-pipe, with the draw-line placed a sufficient distance above the bottom to permit the collection of considerable sediment.

As has been previously stated, the success of a tank



VIEW OF COMPLETED TANK.

of this nature depends primarily on the engineer and the class of workmen employed on the work; on the engineer, for his judgment on safe bearing powers of soils, allowable and working stresses and the selection of materials; on the workmen for thoroughness in mixing and placing the concrete and executing the work in general.

The accompanying photographs illustrate the methods used to construct a tank of type *A* on the peak of a hill. The tank was for domestic water supply and the requirements were as follows: capacity, 50,000 gallons, height of floor above the ground 40 feet. Because of the height of the tower it was deemed advisable to use a beam-and-girder floor instead of a flat slab in order that the floor might be as rigid as possible under the severe wind stress to which it would be subjected. The columns rested on piers and were braced half-way up by a collar-beam. The soil was hard clay. The columns were poured in place simultaneously. The column-forms were constructed so as to permit short tamping to avoid flaws or stone pockets. The concrete in the wall and floor was run continuously. Two coats of Medusa Waterproofing were applied as soon as the forms were removed. The tank has been in use for over three years and as yet has shown no signs of cracking, checking, or leaking and the wall is dry.

The tank was designed by me and was constructed by J. L. Ackland of Los Angeles. The total cost, including contractor's profit, was less than $2250.

COST OF GRADE-CROSSING PROTECTION

Methods and costs of grade separation at crossings are discussed in *Railway Engineering and Maintenance of Way*. Probably the most extensive grade-separation in the United States has been done on the Long Island railroad. At the present time there are 953 crossings; 305 of these are absolutely protected, 118 by an elevated crossing, and 187 by a depressed one; 193 are protected by gates; 46 by flagmen or guards; and 72 by other methods, such as bells or other mechanical devices. On account of the flat character of the country, the cost of grade separation on this railroad is unusually high. The average cost of protecting crossings by the different methods is as follows:

By elevation	$200,000.00
By depression	200,000.00
First cost of gates	350.00
Maintenance of gates per year	38.60
Wages of gate-tender per year	557.12
Total cost of gates per year	595.72
First cost of bells, direct current, per year	912.50
First cost of bells, alternating current, per year	1,824.50
Maintenance of bells, per year	78.05
Wages of flagmen at crossing without gates, per year	548.44

The Chicago, St. Louis & Kansas City railroad has 990 unprotected crossings, and 315 protected, 39 overhead, 87 depressed, 43 by gates, 58 by flagmen, and 88 by bells. The average cost for grade-separation in the city of Chicago has been $44,000. The first cost of gates is $600, with wages $32.50 per month. The first cost of bells is $300.

Costs of surveys for the Los Angeles flood-control project are given in the report of the Board of Engineers. Topographical surveys, taking 5-ft. and 2-ft. contours, were made of 268.4 square miles, most of it open and fairly level country, at a cost per square mile of $157.75 for field work and $19.28 for office work, a total of $177.03. Traverses were run of 209.2 miles of canyons, at a cost per mile of $31 for field work and $12 for office work, a total of $43. These were mountain canyons with steep sides, full of boulders and usually with considerable brush. Primary levels were run for 261.3 miles at a cost per mile of $4.83 for field and $1.45 for office work, a total of $6.28. Preliminary location surveys were made for 25.2 miles of drainage channels at a cost per mile including cross-sectioning, of $292 for field and $43 for office work, a total of $335. Both of the latter kinds of lines were mainly in open, level country.

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System of Accounting and Cost Keeping in Use in the Oregon State Highway Department

By G. ED. ROSS*

From their very nature, construction accounts require entirely different treatment than most any other class of accounts, if the results intended are to be accomplished. The main point about construction accounting is not only to have a record of all transactions, but also to have this record in such shape that the items making up the cost of a piece of work give an intelligent and reliable basis on which to estimate other work. An important feature that should not be overlooked is the fact that timekeepers and men handling clerical matters on construction work are usually engaged a large part of the day in various other duties. These are frequently of such importance that the time spent on cost-keeping and accounts is looked upon as a side issue. If the system of accounting employed is intricate and top-heavy with detail, it encourages guesswork and carelessly kept records, which at the close of the job will be found inadequate and incomplete, and of little value either as a basis for the cost of that work which they are intended to cover, or for the computation of estimates on future jobs of a similar nature. It is therefore evident that the simpler an accounting system is in its operation, provided that it has the essentials, the more accurate and workable the cost data will be when finally compiled.

The essentials for a practicable accounting system for construction work should embody the following features:

(a) An accurate record of all obligations as they are made, that the state of finances may be known at any time with a minimum of uncertainty.

(b) Individual items of cost of structures on divisions of the work kept in such detail and available at such frequent intervals as to give the superintendent an opportunity of checking up and eliminating exorbitant costs from day to day while the work is in actual progress.

(c) Sufficient detail in items of cost with supporting narrative as to conditions prevalent at the time of the work and place where it is done as will make it possible on future work having some elements of similarity to base estimates safely from these costs.

(d) Every original entry, so far as possible, embodied as a portion of the permanent record, thus doing away with unnecessary copying and excessive clerical work.

(e) All cost-keeping records to 'tie in' and be a part of other office records and balance with gross expenditures on the entire work.

(f) Such a check on each gang's work as may show their comparative accomplishments daily, weekly, or monthly. This will create enthusiasm and friendly rivalry among foremen, resulting in greater efficiency and lower unit-costs.

(g) As few books and forms of record as possible to accomplish the above in the most simple and effective manner, with a view of making permanent as many of the original records as practicable.

(h) Men to operate this accounting system who have ordinary horse sense and sufficient judgment to grasp the essential features of construction work on which unit costs are desirable and may be of value later, as well as at time of construction, rather than men who are interested in the clerical work from a clerical standpoint only. Such men are easily found on most construction work. All that is required to make them valuable assistants is a man at their head who is thoroughly familiar with construction accounting and cost keeping, and also has sufficient knowledge of general office and accounting requirements to instruct his field assistants intelligently as to just what records to keep and how to keep them.

In the spring of 1915, with a view to embody the principles outlined above, the State Highway Commission of Oregon had installed under the direction of its Auditor, an accounting system based on one that had been successfully demonstrated during the construction of the Tumalo Irrigation project in central Oregon. This project was built with State funds under the supervision of State officials during the years 1913 and 1914. The main features of the cost keeping system are similar to the system formerly used by the United States Reclamation Service on its construction work, but it has been simplified and otherwise changed, making it suitable for commercial contract work where it is desired to reach substantially accurate results at a minimum cost for clerical labor.

In its operation, few printed forms and books are required. The important book, of course, is the Cost Ledger on which are summarized all the items assembled from month to month. Before actual construction is started, the work is divided into districts and each district into divisions. Divisions are made according to the character of the country in which the construction work is to be done. On highway work they may vary from one to several miles in length. Each division is segregated into features. This should be done carefully, as proper forethought and study at this time will have much to do with the success of the system. It is of sufficient importance to warrant the engineer in charge, the superintendent, and the accountant, going over the work together, feature by feature, that they may start

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with a fairly good understanding of its purpose, and the part each will have in the securing of accurate costs. It goes without saying that these three officials must work absolutely in harmony if the best results are obtained.

A set of account numbers is prepared to cover the items of expense which are chargeable to the general office and which cannot be charged directly to any of the districts, for example, such charges as salaries and expenses of administrative employees and the upkeep of the general office, which expense is for the benefit of the entire job, but cannot be pro-rated fairly at the time the expense is incurred. Account numbers are prepared for each division which may have the following features: General Expense, Preliminary Location, Right of Way, Construction, Subgrade, Culverts and Drains, Bridges, Riprapping, Macadamizing, Hard Surfacing, Camp Construction, Operation of Mess Houses, Corrals, Store House, Blacksmith Shop, and Machine Shop. At the head of each sheet is given the name of the road, county in which it is located, station number, limits comprising this division, width of road-bed, and width of right-of-way. The same items are used over and over on the various divisions, but the numbers assigned are different in each case. There is no repetition of numbers on the job, so that when a number is once assigned, it can mean only one thing. This does away with all chance of confusion. These are listed in what is known as an account-number book, and each number when taken from this book gives full information as to what it is intended to cover. For instance, the item "7305-$16.75" coming into

State of Oregon
State Engineer – Highway Department.
Cost Ledger.

Clatskanie Bridge,
Columbia County.

Bridges & Miscellaneous Structures.

Account Number.	Classification.	Month of ..... 19....: This Month.	Total to Date.	Month of ..... 19....: This Month.	Total to Date.	Month of ..... 19....: This Month.	Total to Date.	Account Number.
391	Salaries, Engineering.							
392	" Drafting.							
393	" Detailing.							
394	" Clerical & Time-keeping.							
395	" Supervision.							
396	" Expert Engineering.							
397	" Inspection.							
398								
399	Labor Erecting Concrete Forms.							
400	" Taking down " "							
401	" Pouring "							
402	" Placing Reinforcing steel.							
403	" Erecting steel.							
404	" Wet excavation							
405	" Dry "							
406	" Rock "							
407	" Painting structure.							
408	" Placing Concrete pipe & tile.							
409	" Placing metal culvert.							
410	" Applying water-proofing.							
411	" Erecting Falsework							
412	" Taking down "							
413	" Testing materials.							
414	" Test pit, borings, soundings etc.							
415	" Foundation.							
416	" Approach							
417	" Riveting (field) steel.							
418	" Rubble masonry & other Retng walls							
419	" Finishing concrete							
420	" Temporary building.							
421	" Erecting plant.							
422	" Sheeting.							
423	" Pumping.							
424	" Handling materials.							
425	" Repairs to equipment.							
426								
427								
428								
429								
430								
431								
432								
433								
434								
435	M & S Hand-rail.							
436	" Falsework.							
437	" Explosives.							
438	" Cement.							
439	" Reinforcing steel.							
440	" Structural "							
441	" Lumber.							
442	" Paint							
443	" Water-proofing.							
444	" Sand.							
445	" Gravel.							
446	" Nails, bolts, etc.							
447	" Blacksmithing.							
448	" Fuel							
449	" Metal culverts.							
450	" Concrete pipe & tile.							
451	" Metal tubes.							
452	" Pilling.							
453	" Approach.							
454	" Foundation.							
455	" Hydrated lime.							
456	" Temporary building.							
457	" Erecting Plant.							
458	" Sheeting.							
459	" Pumping.							
460								
461								
462								
463								
464								
465								
466								
467								
468								
469								
470								
471	Hauling.							
472	Freight.							
473	Telephone & Telegraph.							
474	M. & S Erecting Plant.							
475	" Repairs, to equipment.							
476	Travel							
477	Advertising, plans, printing, etc.							
478	General charges pro rata.							
479	Administrative charges.							
480	Depreciation on equipment.							

FIG. 1. SPECIMEN PAGE OF COST LEDGER.

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the general office on a summary of account numbers means there had been spent $16.75 for "labor, repairs to equipment" on the Pacific Highway in Douglas county, State of Oregon, Comstock division, between station 200 + 00 and station 60 + 70, a distance of approximately two miles. As will be noted, with the two entries made, all those concerned are fully informed, by reference to their account-number books, as to every detail in the transaction.

Every man in a responsible position has a copy of such portion of the book as may have any connection with the work he is handling. The last item on each feature is Depreciation on Equipment and includes the equipment cost chargeable to each feature of the work. An Equipment Record book is kept in which each piece of equipment, date of purchase, price and estimated time of its usefulness is entered. Depreciation on equipment is computed each month and charged against the feature on which it is used, the amount being based on the estimated period of its usefulness or its estimated value at the completion of the job. At quarterly, semi-annual, or annual intervals an inventory of all equipment is taken, a survey made of its actual value at that time and the equipment charges adjusted accordingly. A sample account-number book for a given job is given below.

COLUMBIA RIVER HIGHWAY, COLUMBIA COUNTY

Division Number Two (Inglis).

Station 476 + 00 to 850 + 00.

Length, about 7 miles. Width of roadbed, 24 ft. Right-of-way, 60 feet.

State engineer. Highway department.

CONSTRUCTION SUB-GRADE

4336 Salaries, engineering.
4337 " drafting.
4338 " clerical and timekeeping.
4339 " miscellaneous.
4340 Labor, superintendence.
4341 " plowing.
4342 " excavation.
4343 " earth excavation.
4344 " hard rock excavation.
4345 " loose " "
4346 " soft " "
4347 " shell " "
4348 " overhaul.
4349 " repairs to equipment.
4350 " blacksmith and tool sharpener.
4351 " ditching and drainage.
4352 " soaking.
4353 " rolling.
4354 " disposing of slides.
4355 " riprapping.
4356 " freighting materials.
4357 " handling "
4358 " carpenter work.
4359 " cribbing.
4360 " falsework.
4361 " finishing.
4362 Labor, materials, and supplies, road-grader work, including plowing, laborers, and teams.
4363 Labor, materials, and supplies, grade crossings.
4364
4365
4366
4367
4368
4369
4370
4371
4372
4373
4374 Materials and supplies, explosives.
4375 " " " ditching and drainage.
4376 " " " soaking.
4377 " " " rolling.
4378 " " " disposing of slides.
4379 " " " lumber.
4380 " " " cement.
4381 " " " repairs to equipment.
4382 " " " blacksmithing.
4383 " " " fuel.
4384 " " " falsework.
4385 " " " finishing.
4386
4387
4388
4389
4390
4391
4392
4393
4394
4395
4396
4397 Telephone and telegraph.
4398 Contractor's earnings.
4399 Rental of equipment.
4400 Travel and livery.
4401 Freight and express.
4402 Legal expense.
4403 Advertising.
4404
4405
4406
4407
4408 General charges, pro rata.
4409 Administrative, pro rata.
4410 Depreciation on equipment.

At the end of the quarterly period, the expense of the general office is pro-rated over to the district offices according to the proportion of work done in each district. The general expense in the district office is at the same time pro-rated to divisions and features of the work. The values of the equipment and store-house supplies are taken, and these, if added to the cost ledger, should balance with the voucher register and bills payable, and include every charge that has been incurred. This results in the production of a record of actual costs including everything for which money has been expended.

There is no comparison between this method of securing cost with an absolute check on every transaction, and the method once quite common on construction whereby the resident engineer secured as much data as came through his hands without any actual check as to its correctness, or reference to general office records and overhead expense. The administrative cost is just as much a part of the unit cost of moving materials as the wages of the man at the end of a No. 2 shovel. Too frequently this expense is overlooked in making estimates on new work.

Fig. 1 shows specimen page of the cost ledger, with

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account-numbers as outlined above, feature by feature, each explained by its heading. It will be noted that several blank numbers are left to be used as the work progresses, when it is desirable to add special items not foreseen in the beginning and on which costs are desired. This may appear complicated at first. It must be borne in mind, however, that only a few of the account numbers are in use at any one time. For instance, on the cost of erecting bridges, we have 'labor erecting concrete forms' and 'labor taking down concrete forms,' 'labor pouring concrete' and 'labor placing reinforcing steel,' 'material and supplies, cement,' 'material and supplies, lumber.' There are 90 numbers in this feature, and when the work first starts, it is probable that aside from the items above enumerated, not over three or four others in the feature would be used the first month. At a later period, as the work progresses, such items as 'erecting steel,' 'erecting falsework,' 'testing materials' and 'field riveting,' would come into use and so on throughout the job, so that at the end of the work nearly all of the 90 numbers designated would have a charge. If all other records were lost, the cost ledger itself would show a fairly good record of the monthly progress of the work.

If this system is to achieve the results of which it is capable, a summary of labor costs should be made frequently, possibly every evening which on an ordinary piece of work should not take the timekeeper over half an hour. This gives the superintendent an idea just how the costs are running while the work is still fresh. If they appear to be excessive at any one place, he can give his immediate attention to that particular point. If he is thoroughly in touch with the work he frequently can find the trouble in a fairly definite manner without leaving the office. It is this feature of the system which is considered its greatest value, inasmuch as when properly handled, it increases the efficiency of the superintendent and his foreman and makes real money for the contractor through the medium of lower unit costs and greater accomplishment for each gang of workmen.

Accounting is sometimes looked upon as a sort of necessary evil and dead expense. The sales department in the average commercial business is no more effective in its functions of preserving and stimulating the life of the business than is this method of accounting when placed in its proper relationship to the work. It is a barometer for every activity on the job, and must show a little more speed in its operation than the speediest foreman or superintendent, if it retains its position as 'pace setter' for the organization. In this age of close competition and advanced methods, when the element of guess-work on construction estimates is practically eliminated, the accounting system which is only 'at home' at the rear of the procession, is of little real value.

Segregating of the items is left to the men interested in the cost-keeping and is determined largely by the character of the work. Finer divisions can be made or the number materially reduced on the other hand according to the judgment of those in charge. This element of elasticity of the system is another one of its strong points. However, it should be understood thoroughly that the account numbers, regardless of how many there may be in a book, will never give trouble in case they are not used. The space they take in the book is unimportant, so that in laying out a piece of work, it is well to have sufficient items to cover every detail of work that may possibly arise so that after the work has been completed it may not be found that costs are desired on several items which it is then too late to secure because of lack of forethought and knowledge of construction work when the account-number book was arranged.

In case it is necessary at any time to make changes or additions in the account-number book, these changes should be made only by the person responsible for all accounting. Copies of changes should be sent to all who may be interested before insertions in the book are made, so that the books in the field and cost-ledger items may be identical at all times. The observance of this rule is of great importance.

The time-book sheet should have a column for the insertion of account numbers, names of employees, occupations, time worked, rates, amounts earned, deductions, and amounts due. As a rule on ordinary construction jobs, one man will not be working under more than two or three numbers during the entire month. The exceptions are in the case of foremen, roustabout, blacksmith, timekeeper, and a few others whose duties make it necessary to charge their time to nearly every feature of the job. These men should be given from two spaces to a whole page, depending upon requirements. It is convenient to give space for four account numbers in each division of the sheet. At the close of the month a recapitulation by pages of the time of the men is made. There is also a summary of account numbers made. This summary of account numbers and recapitulation of the timebook, showing the amount earned, should balance. If they do, the timekeeper can feel reasonably assured that his computations are correct. The timebook is then sent to the general office, the bookkeeper there taking off the summary and posting it in a classification book which is used to assemble the items for posting to the cost ledger.

The invoices passing through the field, after being carefully checked and approved by the proper person, should have inserted on them the account number to which the items are chargeable, and are then sent to the general office for payment. The account numbers and charges are copied in the classification book as they come into the general office. At the close of the month, when all accounts are in, the classification book is balanced and the gross amounts chargeable to each account number which has been active that month, are posted in the cost ledger, which contains the account numbers and items identical with those in the account-number book. When this has been completed and the cost ledger balanced, the items are also added crosswise of the page. This gives the

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totals to date and by months on each item and by feature of all work.

The number and size of books recommended for this system varies according to the size of the project. The following outline should cover the ordinary construction job, with such additions and alterations as may, in the judgment of the accountant, seem desirable.

(a) Cost Ledger
(b) Voucher Register } Controlling Accounts.
(c) Check Register

An ordinary I-P Ring Binder No. 701, size about 9 by 12 in., makes a satisfactory cover for all three of these forms, one cover for all, with the proper divisions, giving a convenient and compact record. As the record grows in size and features are completed, transfers may be made of sheets to inactive binders.

(d) Condensed financial reports and general pertinent information. For this purpose a convenient size is a sheet 4½ by 7 in. with a No. 6 Morden's loose leaf binder or similar book, pocket size, which is usually carried by engineers and superintendents on their work.

(e) A small form with insert for carbon sheet about 4 by 7 in. which makes a convenient book for requisitions, orders to foreman, and for general memoranda where it is desirable to retain a copy.

(f) Time-book sheet.

(g) Check book.

(h) Classification book.

(i) Equipment-record book.

(j) Storehouse stock-book.

(k) Special forms for reports by foremen to superintendents, for use of the timekeeper in checking time of men that he has taken during the day, and other miscellaneous reports which may be worked out to fit the particular piece of work under way.

There are two advantages in the use of the smaller binders and forms. One is the cost of printing the smaller form and the lack of waste in its use. The other is that it makes a convenient record to take into the field or to public meetings. When it is remembered that the value of the chief accountant is based largely on his intimate knowledge of field conditions which necessitates much of his time being spent on the work, the advantage of the compact record is apparent.

This system is not based on theory, but has been worked out after eight years experience on a great variety of construction work both in the field and in general offices. I have never found an instance in construction work where, given a little applied intelligence, this method did not cover the situation. To get results, however, there must be co-operation between the field and office forces. The superintendent and engineer should go over all summaries of account numbers carefully before they are sent to the general office. By each one working in his place and spending a little time on this important matter, errors will be reduced to a minimum and the fullest detail will be available at the close of the work.

Insofar as nearly every construction job varies in detail, it requires a specially constructed accounting system to handle it. The plans outlined above with a little adjustment can be easily made to fit any piece of work. When the principle is once thoroughly understood, the details of working it out will be found simple. If desired, I will be glad to explain any special feature of this work in greater detail.

PIPE-LAYING ACROSS A SMALL STREAM

Methods of laying a small cast-iron pipe across a narrow stream were described by Chas. R. Gow in a paper read recently before the Boston Society of Civil Engineers. The crossing being part of a sewer line, it was essential to maintain an even grade. The stream was approximately 75 ft. wide and 5 ft. deep. As the river was used for boating, no obstruction which would interfere with such use was permitted. The bed of the stream was gravel overlying a deposit of mud. The crossing was close to and parallel with an existing highway bridge, from which all of the work was done.

A platform steam-derrick mounted upon rollers was erected on the bridge so that it could be moved back and forth as the work progressed, the boom being long enough to reach the pipe-line. A small orange-peel bucket was used to remove the gravel slopes at either bank as well as to dredge the shallow trench necessary for the pipe. A pair of wooden leads containing a pile-driving hammer was suspended from the boom end, which was securely guyed in position, while spruce piles were driven in bents of two, spaced 3 ft. centres. There were 22 piles or 11 bents required in all.

It was necessary to cut and cap the piles at an exact grade. As the cutting-point was more than 5 ft. under water, the following method was devised to accomplish the purpose:

A light rivet-steel cylinder 6 ft. in diameter and 10 ft. in length was lowered over a bent of two piles until it rested vertically upon the bottom. To seal the bottom edge, some sand and gravel was deposited around the outside. A pulsometer pump was then swung out by the derrick, and the suction-pipe lowered into the cylinder. By means of a steam connection with the hoisting engine the water was removed from the interior of the cylinder so that men could enter, cut the piles with an ordinary cross-cut saw, and cap them at the required grade with 6 by 6-in. timbers. When this operation was completed, the cylinder was withdrawn and placed over the next bent of uncut piles.

When all of the pile-bents had been thus capped, the pipe was assembled on the bridge and the joints were leaded and caulked. By means of the derrick and a guyed gin-pole, the entire length of pipe was suspended over the desired position and lowered through the water till it rested on the pile caps previously placed. A diver was employed to wedge the pipe securely in place, this being the only part of the work on which a diver was used. The pipe was then backfilled with some of the dredged material.

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Oil Pipe-Line Systems in California

By C. P. BOWIE*

One of the most important factors in the petroleum industry today is the pipe-line. Notwithstanding this and the further fact that oil was discovered in California many years ago, the pipe-line as a means of transportation in that State has been slow to develop.

There are a number of reasons for this delayed development. In the first place the oils originally produced in any quantity came from shallow wells and were of low gravity, 12 to 14° Baumé. The difficulties experienced in moving such viscous material, especially in cold weather, through even the short gathering lines in the fields themselves, were so great that the successful operation of trunk-line systems, such as were in common use throughout the eastern and southern states, at that time seemed a physical impossibility. In the second place the oil was practically all of an asphaltum base, for which reason it was not considered desirable for refining purposes. Further, the western public had still to be educated as to the superiority of oil over other kinds of fuel. The market price was consequently small; in many cases not over 15c. per barrel at the well. So it is no wonder that it was hard to obtain capital for investment in pipe-lines.

It was not until the spring of 1900 that the Pacific Coast Oil Co., later taken over by the Standard Oil Co. of California, began the construction of an 8-in. line about 32 miles long from the Santa Maria field, in Santa Barbara county to Port Harford in San Luis Obispo county. Shortly after this, the Standard Oil Co. constructed several lines, none of them more than 30 miles long, in Los Angeles, Orange, and Ventura counties. These lines were from 3 to 8-in. diameter. Most of them are still in use. In 1902 the same company completed an 8-in. line, 290 miles long between the Kern River field, in Kern county, and Point Richmond, Contra Costa county, where it constructed a large refinery. The pumping stations on this line were originally placed 28 miles apart, but because of the great difficulty of moving the oil, the number of stations was doubled, so that they are now 14 miles apart. A second line, composed partly of 8-in. and partly of 12-in. pipe has since been built parallel to the first; also three branches. One is a double line of 8 and 12-in. pipe, 32 miles long from the Midway field in Kern county, to the initial station in the Kern River field; another an 8-in. line 21 miles long from the Lost Hills field in Kern county to Pond Station; and the third an 8-in. line 29 miles long from the Coalinga field to Mendota Station in Fresno county.

In 1904, the Associated Oil Co. constructed a 6-in. line, 105 miles long, from the Coalinga field to tide-water at Monterey. In 1907 the same company completed an 8-in. line from the Santa Maria and Cat Canyon fields to Gaviota, about 50 miles. About the same time, the Amalgamated Oil Co., a subsidiary of the Associated Oil Co., built a line composed of 3, 4, and 6-in. pipe from the Salt Lake field to Los Angeles, a distance of 7 miles.

In the spring of 1908, the Associated Pipe Line Co. completed an 8-in. line, 283 miles long, from the Kern River field to tide-water at Port Costa, a town on San Francisco bay, 28 miles east of Oakland. In an effort to reduce the friction in pumping, this line was constructed of rifled pipe and is operated under what is known as the 'rifled' system, which I have described elsewhere in detail.† The stations are 24 miles apart and it is the only system of its kind in the world. The year following, the same company built an 8-in. line from Coalinga to Port Costa, 190 miles long, and a few months later extended it 88 miles to the Midway field in Kern county.

During 1910 the Producers Transportation Co. constructed 6 and 8-in. lines in the San Joaquin valley, having an aggregate length of 147 miles, extending northerly from the Midway and Kern River fields and southerly from the Coalinga field to a point in Kern county, known as Junction Station and from this station to the coast near San Luis Obispo, a distance of 74 miles. This last portion of the system has since been doubled so that now two 8-in. lines connect Junction Station and the coast.

The General Pipe Line Co. transports oil through an 8-in. line, 156 miles long, from Midway to Los Angeles, having an 8-in. branch 52 miles long, from a pumping station known as Liebre, in Kern county, to Mojave, a town on the Santa Fe and Southern Pacific railroads. This line, with its branch, traverses a mountainous country. It passes over the Tehachapi range at an elevation of 4212 feet.

The Union Oil Co. has lines serving San Luis Obispo, Santa Barbara, Ventura, Los Angeles, and Orange counties. They are composed of 3, 4, 6, and 8-in. pipe and have a total length of 159 miles.

The Valley Pipe Line Co., a subsidiary of the Shell Oil Co., has just completed a line partly 8-in. and partly 10-in. diam. to transport oil a distance of 180 miles from the Coalinga field to a large storage-farm and refinery, which the Shell Oil Co. is building near Martinez, in Contra Costa county. When this line is operating to capacity, which will probably be within the next few months, there will be seven companies in California engaged in the business of transporting oil by pipe-line. The aggregate length of their lines is approximately

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†*Mining and Scientific Press*, Vol. 103, p. 293.

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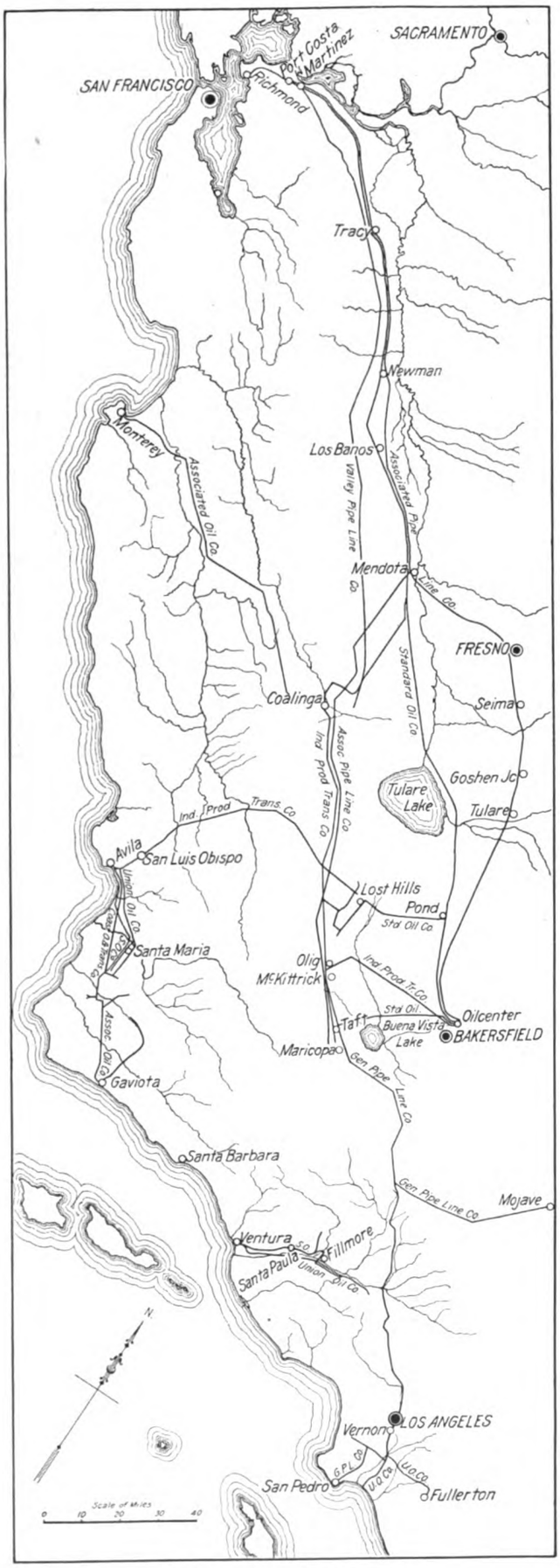

MAP SHOWING MAIN PIPE-LINES.

2000 miles and their estimated daily terminal capacity will be 370,000 barrels of 42 gallons.

Pipe. The pipe used is what is known as hydraulic steel line-pipe. It has screw couplings and is delivered by the mills in lengths of about 20 feet. The 6-in. pipe weighs 19.37 lb. per ft., the 8-in., 29.2 lb. per ft., the 10-in., 41.6 lb. per ft., and the 12-in., 50.9 lb. per ft. The specifications for such pipe include the following requirements:

Carbon, not over 0.9%.

Phosphorus, not over 0.105%.

Manganese, not over 0.45%.

Sulphur, not over 0.045%.

Tensile strength, not over 50,000 to 62,000 lb. per square inch.

Elastic limit, not less than one-half tensile strength.

Elongation in 8 in., not less than 20%.

Reduction in area, not less than 50%.

The 6 and 8-in. pipe is subjected to a hydrostatic test-pressure of 1200 lb. per sq. in., the 10 and 12-in. pipe to 1000 lb. per square inch.

Pipe Coverings. The pipe is buried in the ground wherever possible, with from 2 to 3 ft. of cover. Where the lines pass through high, well-drained territory, two coats of ordinary asphaltum paint are sufficient to protect the metal against corrosion, but where they lie in low, poorly-drained territory, as is the case in many places, especially in the San Joaquin valley, deterioration due to alkaline salts in the soil is rapid. There have been numerous instances where new pipe, protected with two coats of paint, has developed pitting extending entirely through the metal in three years.

In an effort to overcome this serious difficulty, a number of different types of covering have been proposed and thousands of dollars have been expended in their application. At the present time practically all of these coverings are in an experimental stage. Those which bid fair to give the best results for strongly alkaline soils are roofing papers stuck to the pipe with a binder of refined asphaltum, the pipe being cleaned thoroughly of all corrosive salts and rust. The outside of the paper is then coated with asphaltum. Surrounding the pipe, before backfilling, with oil-sand from the wells or with sand saturated with crude petroleum, wrapping the pipe with burlap soaked in asphaltum paint, and painting with asphaltum and coal-tar enamels have been tried with varying success. The line of the Valley Pipe Line Co., between Coalinga and Martinez, was covered for its entire length with a coal-tar enamel about $\frac{1}{8}$ in. thick. This line, however, is practically all in high, well-drained territory, so that little if any of it passes through strongly alkaline ground.

Pumping Stations. Pumping stations, with the exception of those on the 'rifled' line, are placed from 12 to 15 miles apart, on an average. Those on the 8-in. lines are designed to deliver about 1200 bbl. an hour against a working pressure of 800 lb. per sq. in. As a matter of fact most of them do not carry line pressures higher than 600 lb. per sq. in. The stations on the

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6-in. lines deliver 600 bbl. per hour against similar line pressures.

The main-line pumps are of the horizontal reciprocating type, either compound or triple-expansion. The compound pumps are usually 22 by 38 by 9½ by 36-in., and the triple pumps 18 by 28 by 48 by 9½ by 36 in. Crank and fly-wheel pumps are also used on the plan of a Corliss engine, direct-connected by cross-yokes and side-rods to cast-steel oil-ends. There are also two feed-water pumps, a hot-well pump, a general-utility pump, fuel-oil set, a small dynamo for furnishing electric lights, one or two deep-well pumps or an air-compressor, and in some cases an ice-machine and a gas-machine. Where the water carries a high percentage of mineral compounds, there may also be a cooling-tower and a condensing-set.

At each station, with the exception of those along the 'rifled' line, there are two or more oil-heaters placed in the pump suctions and used as a means of reducing the viscosity of the oil before it enters the line. These heaters are from 48 to 60 in. diam. and about 25 ft. long. They are constructed somewhat on the principle of a return tubular boiler, the oil occupying the space ordinarily filled by the hot gases and exhaust steam filling the water space. Thus they serve the double purpose of heating the oil and condensing a considerable proportion of the exhaust steam. The condensed steam is returned to the boilers.

The boiler-room usually contains three 250-hp. horizontal water-tube boilers. Except in a few cases where gas can be obtained, the fuel used is oil.

The buildings consist of a pump and boiler-house, either under one roof or in separate structures, and made of corrugated iron or wooden or steel frames, or in the case of the Standard Oil Co. lines, of brick; a bunk-house for the roustabout and traveling employees, from three to five cottages for the pumpers and their families, a barn, tool-shed, blacksmith shop, out-houses, etc. The tank equipment includes one or two oil-tanks of 30,000 to 55,000 bbl. capacity, a 5000-bbl. water-storage tank, a 500-bbl. feed-water tank and two 100-bbl. fuel-oil tanks, besides a small tank mounted on a tower for furnishing domestic water to the cottages.

Water Supply. The water supply is obtained in almost all cases from wells. These vary in depth from shallow dug wells, 20 to 30 ft. deep, to drilled wells 1500 ft. deep. There are but few cases where the water taken from wells can be termed good boiler water. At many stations, especially those which derive their supply from deep wells, it has been found necessary to put in a cooling-tower and condensing apparatus to save as much of the exhaust steam as possible. Even then it is often necessary to treat with chemicals the comparatively small proportion of 'make-up' water required before admitting it into the boilers. At these 'bad-water' stations, the water for domestic use is distilled.

Telephone and Telegraph System. Nearly all of the companies operating trunk-lines have their system completely equipped with telephone and telegraph, so that any station, no matter how isolated, can be brought into instant communication with the home office. The route of the telephone lines is, as nearly as possible, along the pipe-line. This greatly facilitates finding trouble and repairing breaks in the pipe, since the line-walkers carry pole-climbers and portable telephones so that they can communicate with headquarters from any point in the field.

Operating Organization. The systems are operated by a general manager, whose office is situated at or near the terminal of the system, usually in one of the larger cities. There is a general superintendent, with offices at some central point, who reports to the manager. If the system is a long one, it is divided into sections each one of which is in charge of a division superintendent, reporting to the general superintendent. The crew at a pumping station usually includes two engineers, two or three firemen, and a roustabout, whose duties may also include washing boilers. There are traveling forces who cover certain divisions of the line or the entire system, as may be required. These include repair crews, line-riders and line-walkers, machinists, boiler inspectors, boilermakers, bricklayers, carpenters, electricians, and chauffeurs. At the initial and terminal stations, gaugers are employed to measure and test the oil. At some central position along the system such as the general superintendent's office, a storehouse and machine shop is placed, from which supplies, such as gaskets, packing, and oil are furnished to the various pumping stations and to which small machinery and machinery parts can be sent for repairs or general overhauling.

Hypochlorite and liquid chlorine for the disinfection of water supplies is discussed by Francis F. Longley in a paper presented before a recent meeting of the American Waterworks Association. Returns from cities in the United States and Canada, using a total of nearly two billion gallons of water daily, are summarized. About 80% use hypochlorite and the remainder liquid chlorine. Disinfection is used in connection with other treatment, usually filtration, in 63% of the cities. The cost per million gallons treated daily for the equipment used varies between wide limits, mainly because the character of the equipment is also variable. The lowest cost is $4 per million gallons daily and the highest is $2400, but in most of the cities the cost is between $50 and $500 per million gallons daily. The cost for the treatment itself is also variable, but in most cases is between $0.10 and $0.50 per million gallons, with an average of $0.25. Except for the chlorine-containers, which are always iron cylinders, there is a similar variation in the materials used for the apparatus, but the best results seem to have been obtained with concrete tank, lead pipe, and rubber composition valves and fittings. The proportion of available chlorine in the hypochlorite varies from 15 to 42%, with an average of 33%. As much as 37 lb. per million gallons has been used without objectionable odors.

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Engineers' Note Book

CHART FOR DESIGNING REINFORCED CONCRETE HIGHWAY BRIDGES

By H. DEVEREUX*

The accompanying chart may be used for designing and estimating reinforced concrete highway bridges of the type in use on the California State highways.

Bend. Mom. in ft. Tons	Clear span in feet	Stem of Inside Girders	Area of Steel	Selection of Square bars	Stirrups Number	Stirrups Size	Stirrups Length	Stem of Outside Girders	Selection of Square bars	Cu. ft. Concrete per Sq. ft.	Wt. of Steel per Sq. ft.	Form Lumber per Sq. ft.	Labor Lumber & Profit $	Cu. Yds. Conc. per Span	Tons of Steel per Span	Sax. of Cement per Span	Clear Span
60	22	14" x 19"	4.8 □"	9 - 3/4" □	14	1/2"	60"	12 x 15"	5 - 3/4	1.24	6	4.0	.56	21	1.45	116	22
72	24	" 21	5.2	7-3/4 2-7/8	16	"	65	" 17	5 - 3/4	1.28	6.5	4.1	.58	24	1.63	132	24
84	26	" 23	5.5	6-3/4 3-7/8	18	"	70	" 19	6 - 3/4	1.32	7.0	4.2	.59	26	1.90	143	26
98	28	" 25	6	4-3/4 5-7/8	18	"	75	" 21	6 - 3/4	1.34	7.5	4.3	.60	29	2.2	160	28
112	30	" 26	6.6	9 - 7/8	20	"	77	" 22	5 - 7/8	1.35	8.1	4.4	.61	31	2.55	170	30
128	32	" 27	7.1	7-7/8 2-1"	20	"	80	" 23	5 - 7/8	1.36	8.5	4.5	.62	34	2.85	187	32
144	34	" 28	7.7	5-7/8 4-1"	22	"	85	" 24	6 - 7/8	1.38	8.8	4.6	.63	36	3.15	198	34
162	36	" 29	8.4	3-7/8 6-1"	24	"	90	" 25	6 - 7/8	1.42	9.0	4.7	.64	40	3.4	220	36
180	38	" 31	8.7	2-7/8 7-1"	24	"	95	" 27	5 - 1"	1.46	9.3	4.7	.66	43.5	3.7	240	38
200	40	" 33	9	9 - 1"	26	"	100	" 29	5 - 1"	1.5	9.6	4.8	.68	46.5	4	256	40
220	42	15 x 39	10	5-1" 4-1 1/8	28	"	105	" 29	7 - 7/8	1.54	9.9	4.9	.70	50.5	4.35	277	42
240	44	" 35	10.3	4-1" 5-1 1/8	28	"	110	" 31	7 - 7/8	1.58	10.3	5	.72	54	4.75	297	44
264	46	" 37	10.7	3-1" 6-1 1/8	30	"	115	" 33	6 - 1"	1.62	10.7	5.1	.73	58	5.15	318	46
290	48	" 39	11.2	9-1 1/8	32	"	120	" 35	6 - 1"	1.66	11.2	5.2	.75	62	5.6	340	48

Floor slabs 7" thick reinforced with 1/2" □ bars, spaced 8" on centers, alternate bars bent up, 14-1/2" □ spacers. Top bars 1/2 x 3'-0" over inside Girders 16" cens. and 2'-0" over outside girders. 2 1 1/2" bars in each guard rail.
Bending Moment in foot tons = Span² ÷ 8 Area of Steel = 3 x B.M. ÷ 2 x depth of Stem.
Stem = distance in inches of Girder below slab. " " " in Side Girders = 5/8 Center
Add Shores to Form Lumber. Pipe Rail worth $1.25 per lin. ft = 2.50 per lin. ft of bridge
Labor based on Carp't. 40¢ Labor 2.50 ~ 8 hours Lumber @ 16¢ per M.
ADD to this; Cost of Cement, Rock, Gravel, Sand, Steel, Water, Haul, Ry. Fares, Bond + Liability.

CHART FOR DESIGNING GIRDER-DECKS FOR HIGHWAY BRIDGES.

Hints on Practice

ALLOWANCE FOR SHRINKAGE AND MACHINING OF CASTINGS

These figures show the amount of contraction that takes place per foot of material:

	In. per ft.
Cast-iron cylinders (large)	3-32
" " (small)	1-16
" pipes	1-8
" beams or girders	1-19
" " " " (for heavy wheels)	1-10
Brass, thick	5-32
" thin	3-16
Zinc	5-16
Lead	5-16
Tin	1-4
Copper	3-16
Malleable iron	1-8
Steel	1-4
Aluminum	1-5

Any casting will in all probability show a slight variation from the above figures, owing to the foundrymen, some of whom will give the mold a little more room than others.

One other item has to be considered, with regard to which one often hears the doubter expressing his ignorance by asking: "How much shall I allow on my castings for machining?" Of course it is impossible to answer this question exactly, for a great deal depends upon cleanness and fineness in casting; but average practice might help many on this point. With castings in lead, zinc, or aluminum, it is always wise to leave at least 1/4 in. all over, because these metals often contract unevenly. There is no waste in leaving this quantity of metal, because the excess is easily melted again for future use. The rule for iron castings is to leave 1/8 in. all over, while for brass or copper castings 1/16 in. is enough. Castings in which twisting while cooling is likely to occur require rather more than this allowance, while small castings require rather less. In small cylinders 1/4 in. of the diameter may be allowed for boring, but when the cylinder is as large as, say, 4 ft. in diameter, not less than 3/8 in. is required.

The pattern should have slightly rounded edges and filleted angles, for much of the strength in a casting depends upon the sharpness being taken out of all corners and angles. Sharp angles in a casting are always a source of weakness, and con-

*Engineer Clinton Construction Co., 140 Townsend street, San Francisco.

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sequently only the patternmaker can supply the necessary strengthening by filleting or chamfering the pattern. It is also wise to leave a slight taper on the pattern, about ⅛ in. per ft., so that the molder may draw the patterns out of his mold easily and without fear of breaking down the mold.

To preserve and keep patterns in good order they should be varnished with a mixture of lampblack, 1 part, shellac, 5 parts, methylated finish, 16 parts, all by weight. The first coat should be rubbed over with glass paper when dry, after which the second coat is applied.—*Mechanical World.*

Book Reviews

THE MECHANICAL WORLD ELECTRICAL POCKET BOOK FOR 1916. P. 240. Ill., index. The Norman-Remington Co., Baltimore. For sale by *Mining and Scientific Press*, San Francisco. Price, 25 cents.

This is the companion volume to the mechanical pocket book which was reviewed in the March number of WESTERN ENGINEERING. The two books are similar and contain a large amount of valuable information in their respective lines. They are perhaps not quite so useful to American as they are to British engineers, but in either case, the purchaser need have no fear of failing to get his money's worth. A diary for 1916 is included in the volume.

ELEVATORS. By John H. Jallings. P. 217. Ill., index. The American Technical Society, Chicago. For sale by *Mining and Scientific Press*, San Francisco. Price, $1.50.

The sky-scraper and incidentally the development of the modern city are both dependent upon the elevator, particularly the passenger-elevator. Nevertheless the literature on the subject is scanty. The present volume traces the development of the primitive hand-power elevators in use for many centuries. Part II discusses steam and hydraulic elevators. The first passenger-elevator was installed in New York in 1858. Part III describes the electric elevator. The causes which led to the almost complete abandonment of the steam elevator and the partial disuse of the hydraulic type in favor of the electric elevator are considered. The book is well illustrated with both photographs and diagrams of apparatus. Some of the elevators shown are used in smelters and reduction-works.

MECHANICAL DRAFTING. By Charles B. Howe. P. 147. Ill., index. John Wiley & Sons, New York, 1916. For sale by the *Mining and Scientific Press*, San Francisco. Price, $1.75.

If this work were to be judged from its title alone, it might be inferred that it dealt with mechanical or machine drawing only. This, however, is not so, as it takes the student through from the beginning, including the care and selection of instruments and materials, architectural studies, mechanical studies treated as problems in orthographic projection, topographical, and development in sheet-metal work. The work is intended as a text-book for preparation schools, and as an assistance to the teacher rather than a manual of self-instruction; but the illustrations are treated in a simple manner, making it an easy interpretation for the student. Chapter II is devoted to lettering, a subject of much importance, yet here it is discussed in an abridged manner. In selecting and maintaining an efficient drafting corps for large corporations, more attention is being given to free-hand lettering, and even by small concerns. A poorly delineated drawing may be made plain and attractive by good lettering, for it is the lettering that gives character to the drawing. Orthographic projection and geometric drawing are covered in 23 pages. Chapter V is devoted to working drawings. The next one includes a number of plates for conventional details and simple machine parts. The following 31 pages deal with the architectural treatment of plans and structural details. Then comes topographical drawing. The work is concluded with perspective and shade-line drawings; the illustrations for the latter are poor and could have been treated much more forcefully.

INDUSTRIAL LEADERSHIP. By H. L. Gantt. P. 128. Ill. Yale University Press, New Haven, 1916. For sale by MINING AND SCIENTIFIC PRESS. Price, $1.

The five lectures comprising this book were heard by the senior class of the Sheffield Scientific School in 1915. The methods of industrial leadership are based on the system of scientific management evolved by Taylor, with whom the author was a co-worker; the chief doctrine of this school is that efficient management of labor increases profits and wages.

A novel point brought out is that an impartial study of the Lawrence strike showed that the labor leaders had a much better understanding of the problems involved than the employers, and that no permanent industrial peace can be hoped for until the employers are better educated. The great profits of the Ford automobile are held to disprove the old theory that great profit can only be had by high prices. A fault of the book is the failure to consider the strenuous objections of the trade unions to scientific management.

Engineering Societies and Conventions

IDAHO SOCIETY OF ENGINEERS. Ira F. Schaffner, secretary, Boise.

Los Angeles Section of AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Ford W. Harris, secretary, 1029 Higgins building.

Los Angeles Section of AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Edward Woodbury, secretary, 255 East 3rd street.

OREGON SOCIETY OF ENGINEERS. Orrin E. Stanley, secretary, room 409, City Hall, Portland.

Portland Section, AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Paul Lebenbaum, secretary, 45 Union Depot.

Portland Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. Charles McGonigle, president, care Western Sheet Metal Works.

San Francisco Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. E. T. Thurston, Jr., secretary, Mechanics Institute building.

San Francisco Section of AMERICAN SOCIETY OF MECHANICAL ENGINEERS. F. W. Gay, secretary, care J. G. White & Co., Alaska Commercial building.

San Francisco Section of AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. A. G. Jones, secretary, 811 Rialto building.

Southern California Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. W. K. Barnard, secretary, 701 Central building, Los Angeles.

The first number of the *Quarterly Journal* of the MONTANA SOCIETY OF ENGINEERS has just been issued.

The ENGINEERS' CLUB of San Francisco held a smoker at the club-rooms, 57 Post street, the evening of March 10.

A special meeting of the San Francisco Association of Members of the AMERICAN SOCIETY OF CIVIL ENGINEERS was held March 14 to discuss the proposed amendments to the constitution of the national society.

A joint meeting of the San Francisco Chapter of the AMERICAN INSTITUTE OF ARCHITECTS and the San Francisco Association of Members of the AMERICAN SOCIETY OF CIVIL ENGINEERS was held March 16. The general subject of the meeting was 'City Planning' and the speakers and subjects were as follows: Percy V. Long, 'Legal Questions;' M. M. O'Shaughnessy, 'Transportation;' A. A. D'Ancona, 'Schools;' John McLaren, 'Parks and Recreation Grounds;' and Joseph Leonard, 'Real Estate Problems.'

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Coming Conventions

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Spring meeting, New Orleans, April 11-14. Calvin W. Rice, secretary, 29 West 39th street, New York.

AIR BRAKE ASSOCIATION. Annual convention, Atlanta, Georgia, May 2-5. E. M. Nellis, secretary, 53 State street, Boston.

INTERNATIONAL RAILWAY FUEL ASSOCIATION. Annual meeting, Chicago, May 15-18. J. G. Crawford, secretary, 547 West Jackson boulevard, Chicago.

MASTER BOILER MAKERS' ASSOCIATION. Annual convention, Cleveland, Ohio, May 23-26. H. D. Vought, secretary, 95 Liberty street, New York.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Annual convention, Chicago, week beginning May 22. T. C. Martin, secretary, 29 West 39th street, New York.

Personal

CALEB BERRY has been appointed city engineer of Centralia, Washington.

WASHINGTON B. LEWIS has been appointed supervisor for Yosemite National Park.

THOMAS G. BUSH, formerly assistant state highway commissioner of Washington, has resigned.

LEON J. PEPPERBERG, geologist and petroleum engineer, has moved his office to 718 New Call Bdg., San Francisco.

I. B. FUNK has been appointed city engineer of Newport Beach, California, succeeding W. T. WEBBER, who resigned.

JOSEPH C. ALLISON, formerly chief engineer for the California Development Co. has opened offices as a consulting engineer at Calexico, California.

R. H. THOMPSON, for 19 years city engineer of Seattle, and later chief engineer for the Port of Seattle, has been elected to the Seattle city council.

CHARLES E. HEWES, city engineer of Alhambra, California, has been appointed city manager of that city, and will combine the duties of both offices.

JOHN T. WHISLER, engineer for the U. S. Reclamation Service, has recently completed an investigation of irrigation projects in the Rogue River valley, Oregon.

M. M. O'SHAUGHNESSY, city engineer of San Francisco, has been engaged as consulting engineer by the city of San Diego on the reconstruction of the Lower Otay dam.

HOWARD W. HOLMES, formerly bridge engineer for the Oregon State Highway Commission, has opened an office as consulting engineer at 815 Northwestern Bank Bdg., Portland, Oregon.

ROBERT WOOD, city engineer of El Monte, California, has resigned that position to re-enter the service of the St. Louis & Iron Mountain railway, with headquarters at Monroe, Louisiana.

WILLIAM MULHOLLAND, FREDERIC P. STEARNS, and R. H. THOMSON have been engaged by the city of Seattle as consulting engineers to report on methods of stopping leakage from the Cedar River basin.

J. BURDETTE BROWN, hydrographer for the California State Department of Engineering, is investigating flood-conditions in the vicinity of Tulare lake, California, making his headquarters at Hanford.

CHARLES S. POPE, assistant city engineer in charge of street construction in Los Angeles, has resigned that position to become engineer for Warren Bros. Co., with headquarters in Oakland, California.

W. W. HARMON, formerly city engineer of Grants Pass, Oregon, has been engaged by the Oregon-Utah Sugar Co. to supervise the construction of the company's new sugar factory now being built in that city.

W. H. STEWART, formerly surveyor for Lloyds Register of Shipping, with headquarters at San Francisco, has opened offices as a consulting engineer and marine surveyor at 260 California street, San Francisco.

CLARENCE C. JACOB, who has been engineer in charge of the Phoenix, Arizona, district for the U. S. Geological Survey, has been assigned to the charge of the Salt Lake City district, succeeding ELMER A. PORTER, who resigned.

M. M. O'SHAUGHNESSY, city engineer of San Francisco, addressed a joint meeting of members of the American Institute of Architects and the American Society of Civil Engineers at the St. Francis hotel, San Francisco, March 17 on 'City Planning.'

W. H. CARRUTHERS, formerly engineer for Maricopa county, Arizona, has resigned to become engineer in charge of construction in Arizona for the Barrett Manufacturing Co. He has been succeeeded by HAROLD BARGEMANN, who was formerly assistant county engineer.

WILLIAM R. ROY, State Highway Commissioner for Washington, has resigned on account of ill-health. JAMES ALLEN, formerly chief engineer of the State Highway Department has been appointed to succeed him. Mr. Allen's position has been taken by GEORGE F. COTTERILL of Seattle.

Obituary

JOHN J. YOUNG, secretary of the Pacific Foundry Co., died at San Francisco, February 28.

J. C. HOOVEN, president of the Hooven, Owens, Rentschler Co., died at Hamilton, Ohio, March 1.

FRANK H. BUCK, one of the organizers of Associated Oil Co., and for many years one of its directors, died March 9.

ROBERT M. JONES, who constructed the first electric railroad in Salt Lake City, and who practised as an electrical engineer in Utah, Colorado, and Wyoming and other parts of the West, died March 2, at Carlsbad, New Mexico.

JOHN D. MCGILLIVRAY, one of the most prominent contractors in California, who built the outer quadrangle and many of the other buildings at Stanford University, the San Francisco city hall, and also a number of office buildings in San Francisco, died March 25, at his home at Stanford University.

Commercial Paragraphs

The OSGOOD CO., of Marion, Ohio, has purchased the manufacturing plant of the Ohio Tractor Co. The larger machine tools for which crane service is desirable, will be moved to the main plant of the Osgood Co., while the smaller tools and the foundry will remain as at present.

The GENERAL ELECTRIC CO. has issued Bulletin No. 46023, which describes briefly that company's Arc Circuit Volt Meter, a special instrument designed for testing direct-current series arc circuits. The approximate dimensions and the connections, together with prices are included.

CONTRACTORS desiring to increase their stock of equipment will find an excellent opportunity in the auction sale of the equipment used on construction work by the British Columbia Electric Railway Co., Ltd., which takes place at Vancouver, B. C., May 1-4. F. GRIFFIN & CO., of Vancouver and San Francisco, are the auctioneers.

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SAN FRANCISCO, APRIL 3, 1916

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Building Permits

MARCH 24

Six Story Brick Tenements—Cost $80,000. D. & S. Investment Co., owner. SW Ellis and Hyde.

Two Story Frame Tenements—Cost $8000. Simon Fraser, owner. E Shrader 125 N Fell.

One Story Brick Garage and Repair Shop—Cost $5900. Theo. H. Hittell, owner. S Folsom 200 W. Third.

Two Story Frame Tenements—Cost $11,000. S. Tartaul, owner. W Hyde 140 N Union.

Hotel Alterations—Cost $4000. A. P. Giannini Co., owner. SW Mason and Water.

Two Story Frame Flats—Cost $850. Chas. A. Menert, owner. SW 23rd and Vermont.

Three Story Frame Tenements—Cost $13,500. Sarah Lowenbein, owner. S Washington 60 W Divisadero.

One Story Addition to Concrete Building—Cost $5600. Mrs. Sachan, owner. SE Battery and Green.

MARCH 25

Hotel Alterations and Additions—Cost $5000. Sanford Goldstein, owner. N O'Farrell 165 W Mason.

Tenement Alterations and Additions—Cost $8500. Fred K. R. Stokes, owner. E 7th Ave 120 S Lincoln Way.

Two Story Frame Store Building—Cost $4300. Progressive Laundry Co., owner. E Folsom 50 N 17th.

One Story Frame Stores—Cost $12,350. J. A. Fraser, owner. NW Clement and 10th Ave.

MARCH 27

Bank and Hotel Alterations—Cost $41,297. Fugazi Banca Popolara Italiano, owner. 2 Columbus Ave.

One Stork Brick Market—Cost $7985. C. S. Howard, owner. NW Bush 68 W Mason.

Three Story Frame Flats—Cost $6231. G. & R. Morlazinna, owners. W Taylor 100 S Lombard.

Six Two Story Frame Dwellings—Cost $2000 each. Thomas Hamill, owner. W 24th Ave N Balboa.

Three Two Story Frame Dwellings—Cost $2500 each. F. Nelson, owner. N Parnassus 62 W Hillway; 36 E Hillway; 62 E Hillway.

Two Two Story Frame Dwellings—Cost $2500 each. F. Nelson, owner. W 29th Ave 68 and 233 N Irving.

Two Story Frame Dwelling—Cost $2500. F. Nelson, owner. E 28th Ave 155 S Lincoln Way.

Two Story Frame Dwelling—Cost $2500. F. Nelson, owner. W 29th Ave 196 S Lincoln Way.

MARCH 28

Two Story Frame Dwelling—Cost $3500. E. O'Donnell, owner. N 25th 75 W Hampshire.

Eight Two Story Frame Flat Buildings—Cost $5000 each. W Masonic 25, 50, 75, 100, 125, 150, 175, and 200 N Grove.

Two Story Frame Residence—Cost $2900. F. and W. Smith, owners. N Santa Ysabel 300 E San Jose Ave.

Two Two Story Frame Residences—Cost $3900 each. Bradbury Estate Investment Co., owner. E Church 208 and 233 S 22nd.

MARCH 29

Three Story Frame Tenements—Cost $7500. P. Nave and G. Devencenzi, owners. N Union 30 W Jasper.

Two Story Frame Dwelling—Cost $3500. Albert A. Saxe, owner. E 11th Ave 225 S Balboa.

Contracts Pending

Bids will be Received		See Issue of News Bulletin
Apr. 3.	Colfax, Wash., Water-Pipe	Apr. 3
Apr. 3.	Fresno, Cal., Building	Apr. 3
Apr. 3.	Kalama, Wash, Trestle	Apr. 3
Apr. 3.	Los Angeles, Cal., Street Work	Apr. 3
Apr. 3.	North Yakima, Wash., Road Work	Apr. 3
Apr. 3.	Petaluma, Cal., Street Work	Apr. 3
Apr. 3.	Redwood City, Cal, Road Work	Mar. 27
Apr. 3.	Santa Barbara, Cal., Bridge	Mar. 6
Apr. 3.	Santa Barbara, Cal., Bridge	Apr. 3
Apr. 4.	Berkeley, Cal., Street Work	Apr. 3
Apr. 4.	Calexico, Cal., Sewer	Apr. 3
Apr. 4.	Calexico, Cal., Water Supply	Mar. 27
Apr. 4.	Mt. Vernon, Wash., Road Work	Mar. 20
Apr. 4.	Okanogan, Wash., Bridge	Mar. 27
Apr. 4.	Sacramento, Cal., Street Work	Apr. 3
Apr. 4.	Salinas, Cal., Road Work	Mar. 20
Apr. 4.	Salt Lake City, Utah, Building	Mar. 20
Apr. 4.	San Rafael, Cal., Lighting Fixtures	Mar. 27
Apr. 4.	Walla Walla, Wash., Street Work	Apr. 3
Apr. 4.	Watts, Cal., Cement Sidewalks	Apr. 3
Apr. 4.	Yuma, Ariz., Road Work	Apr. 3
Apr. 5.	Billings, Mont., Sewer	Mar. 27
Apr. 5.	Chehalis, Wash., Road Work	Mar. 27
Apr. 6.	Hanford, Cal., Bridges	Apr. 3
Apr. 6.	Pocatello, Ida., Street Work	Apr. 3
Apr. 6.	Portland, Ore., Building	Apr. 3
Apr. 6.	Spokane, Wash., Street Work	Apr. 3
Apr. 6.	Ventura, Cal., Bridges	Mar. 20
Apr. 7.	Berkeley, Cal., Street Work	Apr. 3
Apr. 7.	Oroville, Cal., Bridges	Mar. 27
Apr. 7.	Portland, Ore., Viaducts	Mar. 27
Apr. 7.	Seattle, Wash., Street Work	Apr. 3
Apr. 7.	Redwood City, Cal., Street Work	Mar. 27
Apr. 7.	St. Helens, Ore., Bridges	Mar. 20
Apr. 7.	Spokane, Wash., Street Work	Mar. 27
Apr. 7.	Ventura, Cal., Bridges	Mar. 20
Apr. 10.	Los Angeles, Cal., Generator Sets	Mar. 27
Apr. 10.	Los Angeles, Cal., Road Work	Mar. 27
Apr. 10.	Oakland, Cal., Lighting Fixtures	Mar. 27
Apr. 10.	Ventura, Cal., Road Work	Mar. 27
Apr. 14.	Echo, Ore., Irrigation System	Apr. 3
Apr. 15.	Stevenson, Wash., Road Work	Apr. 3
Apr. 17.	Everett, Wash., Road Work	Apr. 3
Apr. 17.	Los Angeles, Cal., Road Work	Apr. 3
Apr. 17.	Los Angeles, Cal., Street Work	Apr. 3
Apr. 17.	Sacramento, Cal., Bridge	Mar. 27
Apr. 17.	Sacramento, Cal., Bridge	Apr. 3
Apr. 18.	Midvale, Utah, Sewer	Apr. 3
Apr. 19.	Salt Lake City, Utah, Street Work	Apr. 3
Apr. 24.	Everett, Wash., Road Work	Apr. 3
Apr. 24.	Buenos Aires, Argentina, Machinery	Feb. 28
May 1.	Odessa, Wash., Bridges	Apr. 3
May 1.	San Bernardino, Cal., Building	Mar. 27
May 1.	Santa Barbara, Cal., Road Work	Mar. 20
May 15.	Oatman, Ariz., Water System	Mar. 20
May 19.	Ketchikan, Alaska, Coal, Oil, and Gas	Mar. 13

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Construction News

STREET AND ROAD WORK

Anaconda, Mont.—Contract for construction of asphaltic concrete pavement and sewers on Commercial avenue has been awarded to Clifton-Applegate Co., Spokane, Wash., for $41,770.

Berkeley, Cal.—Bids will be received until 10 a.m., April 4, by A. G. Briggs, city clerk, for grading and construction of concrete curbs and gutters, cast-iron culverts, and 2-in. asphalt wearing surface on 5-in. concrete base on Durant avenue.

Bids will also be received until 10 a.m., April 7, for similar improvements on Fulton street.

El Monte, Cal.—Contract for construction of oiled macadam pavement, cement curbs, gutters, and sidewalks on Tyler street has been awarded to S. C. Contracting Co., Washington Bdg., Los Angeles, for $13,020.61.

Eureka, Cal.—Paving of Broadway and of Myrtle avenue is proposed. James Fraser is interested.

Everett, Wash.—Bids will be received until April 17 by County Commissioners for paving 13 miles of permanent highway between Everett and Bothell; estimated cost, $160,000; for paving 4 miles of highway between Everett and Snohomish; estimated cost, $45,000; for concrete pavement on one mile of Vernon road; and for grading and graveling 4 miles of other roads.

Bids will also be received until April 24 for paving 3 miles of highway north of Marysville; estimated cost, $36,000.

Hanford, Cal.—Following were the bids submitted for construction of Lemore-Stratford highway and two miles of Stringtown highway, contract for which has been awarded to Ford & Stout, Bradbury Bdg., Los Angeles: L. S. Atkinson, excavation, $0.50 per cu. yd.; asphaltic concrete base, $0.025 per sq. ft.; topeka top, $0.015 per sq. ft.; guard fence, $0.50 per ft.; Blanchard & Ehrhardt, excavation, $0.60; base, $0.026; topeka top, $0.013; guard fence, $0.35; Bent Bros., excavation, $0.70; base, $0.03; topeka top, $0.02; guard fence, $0.40; Raisch Improvement Co., excavation, $0.47; base, $0.0257; topeka top, $0.015; guard fence, $0.40; Clark & Henery Construction Co., excavation, $0.60; base, $0.03; topeka top, $0.015; warrenite top, $0.02; guard fence, $0.50; Ford & Stout, excavation, $0.50; base, $0.0225; topeka top, $0.0125; guard fence, $0.50.

Contract for construction of curbs on courthouse grounds has been awarded to I. W. Simpson for $0.32 per lineal foot.

Hoquiam, Wash.—Contract for clearing, grubbing, grading, and graveling three miles of East Hoquiam Valley road has been awarded to Nels Johnson for $24,331.

Kingsburg, Cal.—Following bids were received for paving Simpson street along route of State highway; W. A. Kettlewell & Sons, Sanger, $8794; and Johnson Bros. & North, $8949. Bids taken under advisement.

Los Angeles, Cal.—Bids will be received until 10 a.m., April 3, by Board of Public Works for the following street work: asphalt pavement, storm sewer and cement curb, and sidewalks on Los Feliz avenue; grading and oiling, cement curbs, and sidewalks, and concrete gutters on Isabel street; grading and oiling, cement curbs and sidewalks, and concrete gutters on Lexington avenue; and construction of 1486 lin. ft. of 8-in vitrified pipe sewer in 53rd street district.

Board of Supervisors will receive bids until 2 p.m., April 17, for construction of 4.04 miles of 5-in. concrete pavement on Pico boulevard. Estimated cost is $29,159.15.

Bids will also be received until the same time for construction of 2.57 miles of oiled macadam highway between Venice and El Segundo. Estimated cost is $13,306.65.

Contract for construction of concrete pavement on Azusa avenue has been awarded to E. A. Clayton, 1251 Vanderbilt street, for $5745.

Contract for construction of concrete pavement and cement curbs at Burbank has been awarded to E. A. Baker, 407 H. W. Hellman Bdg., for $12,998.

Contract for improving Pico street has been awarded to Coast Construction Co., 353 South Hill street, for $15,612.58.

Contract for improving Bonnie Brae street has been awarded to Coast Construction Co., for $2431.38.

Marshfield, Ore.—All bids for construction of highway from Coquille to Coos Bay have been rejected because of error in call for bids, and work will be re-advertised.

Martinez, Cal.—City Street Improvement Co., 166 Geary street, San Francisco, has been awarded contract for construction of seven miles of concrete pavement on tunnel road for $71,000.

Modesto, Cal.—County Highway Commission has reported in favor of construction of county highway system consisting of 158 miles of roads. County surveyor E. H. Annear is preparing an estimate of the cost of the system, which will be about $1,500,000. Present intention is to construct all roads of concrete, but it is possible that some of the laterals will be of a cheaper type of construction.

Montesano, Wash.—Contract for construction of permanent highway No. 12 has been awarded to Nels Johnson, Hoquiam, for $24,331.39.

Newport Beach, Cal.—City engineer I. B. Funk, 607 South Main street, Los Angeles, is preparing plans for asphalt pavement on all the streets in East Newport.

North Yakima, Wash.—County Commissioners will receive bids until April 3 for graveling one mile of highway from Hillcrest drive west. Estimated cost is $5133. Total cost of highway work during coming year will be about $75,000.

Oakland, Cal.—Contract for improvement of 100th avenue has been awarded to E. H. Sundberg, Oakland Bank of Savings Bdg., at the following unit prices: grading and construction of oil macadam pavement, $0.085 per sq. ft.; concrete curb, $0.33 per ft.; concrete gutter, $0.12 per sq. ft.; 8 by 29-in. corrugated iron culvert, $1.60 per lin. ft.; 8 by 24-in. culvert, $1.50 per foot.

Contract for improving East 8th street has been awarded to E. H. Sundberg, at the following unit prices: grading, $0.20 per cu. yd.; concrete curb, $0.33 per ft.; concrete gutter, $0.12 per sq. ft.; oil macadam pavement, $0.085 per sq. ft.; 8 by 24-in. culvert, $1.50 per foot.

Contract for improving 55th avenue has been awarded to Hutchinson Co., 13th and Franklin streets, at the following unit prices: grading, $0.17 per cu. yd., redwood curb, $0.095 per ft.; concrete gutter, $0.14 per sq. ft.; oil macadam pavement, $0.0825 per sq. ft.; 8 by 29-in. culverts, $1.50 per ft.; 8 by 24-in. culverts, $1.40 per ft.; storm-water inlets, $25 each.

Olympia, Wash.—Contract for graveling 7½ miles of Pacific highway from Toledo south has been awarded to Jarvis & Burkheimer, Seattle, for $13,652.80.

Oroville, Cal.—All bids for graveling Biggs-Princeton road have been rejected.

Palo Alto, Cal.—City engineer J. F. Byxbee is preparing plans for paving several streets with 5-in. concrete base and oil and sand surface. Work includes 23,077 cu. yd. grading, 1,275,860 sq. ft. paving, and 25,475 lin. ft. concrete curbs. Call for bids will be issued in April.

Petaluma, Cal.—Bids will be received until 7:30 p.m., April 3, by F. B. Singley, city clerk, for grading and construction of oil macadam pavement and concrete curbs and gutters on Webster street.

Phoenix, Ariz.—Contract for improving several streets has been awarded to California-Arizona Construction Co., 1700 East Washington street, Los Angeles.

Pocatello, Ida.—Bids will be received until April 6 by J. R. Dawson, city clerk, for improving several streets.

Portland, Ore.—Contract for construction of under crossing at Fairview has been awarded to Coast Contracting Co. for $8736.

Redwood City, Cal.—Following bids were received for construction of 7.58 miles of macadam road from Crystal Springs lake to Halfmoon Bay, with alternate bids for concrete base on portion from Pilarcitos creek to Halfmoon Bay: Tieslau Bros., macadam, $58,204.69, concrete, $76,207.75; J. McReynolds, macadam, $47,530.65, concrete, $60,199.47; Spring Construction Co., macadam, $57,355.56, concrete, $74,858.64; Peterson & Grier, macadam, $54,767.75, concrete, $73,104.20; Blanchard & Ehrhart, macadam, $64,890.45, concrete, $78,890; A. J. & J. L. Fairbanks, macadam, $55,418.89, concrete, $78,756.19; Marin Rock Co., macadam, $53,132.86, concrete, $69,802.36. Concrete pavement selected and contract awarded to J. McReynolds.

Contract for construction of 0.81 mile of highway from Hillsborough city limits has been awarded to Eaton & Smith, 407 11th street, San Francisco, for $14,813.60. Other bidders were: Tieslau Bros., $15,689.80; Marin Rock Co., $16,198.30; Spring

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Construction Co., $16,307.80; C. C. Christensen, $16,506.07; Raisch Improvement Co., $16,602.60; Blanchard & Ehrhart, $16,579.84; and Peterson & Grier, $17,381.65.

Riverside, Cal.—Estimated cost of repair of storm damage to highways and completion of county highway system is $500,000. A bond issue for this amount cannot be made unless the property is increased throughout the county.

Sacramento, Cal.—Bids will be received until 11 a.m., April 4, by M. J. Desmond, city clerk, for the following street work: construction of 8 and 10-in. vitrified pipe sewers on several streets; grading and construction of 4-in. concrete base and 1½-in. asphalt wearing surface, and concrete curbs, gutters, and sidewalks on 17th street; grading and construction of 4-in. concrete base and 1½-in. asphalt wearing surface, concrete curbs and gutters, and vitrified pipe drains on J street.

Contract for grading and construction of curbs, sidewalks, gutters, vitrified pipe drains, and asphalt pavement on concrete base on Rose avenue has been awarded to Teichert & Son, Ochsner building.

Salinas, Cal.—City engineer Davis has prepared plans for asphalt pavement on concrete base on John street. Estimated cost is $11,096.98.

Salt Lake City, Utah—Bids will be received until 10 a.m., April 19, by Gordon Snow, city recorder, for construction of approach to Hillside avenue from Main street. Plans from city engineer S. Q. Cannon upon deposit of $5.

Highway will be constructed in Big Cottonwood canyon. Estimated cost is $25,000, which will be shared by the city, county, and the mining companies.

San Diego, Cal.—Election has been called for May 16 to vote on bond issue of $2,096,000; $495,000 for repair of roads and construction of new ones where old roads have been washed out, $1,126,000 for construction of paved highways, $75,000 for completion of paved highway to Imperial County line, $100,000 for construction of hospital buildings, and $400,000 for construction of bridges.

San Francisco, Cal.—Following street work has been ordered: grading and construction of sewers on Rhode Island street; sewers on Elsie street; grading and construction of curbs, sidewalks, sewers, and asphalt pavement on Judah street and on Hudson avenue; grading and construction of curbs, sidewalks, catch-basins, and asphalt pavement on Miramar avenue.

City engineer M. M. O'Shaughnessy is preparing plans for municipal highway from Railroad and Evans avenues to Hunter's Point. Highway will be 80 ft. wide and will follow bay shore for 2½ miles.

San Jose, Cal.—Contract for construction of asphalt pavement on concrete base on two parts of 4th street has been awarded to M. W. Painter, at 15c. and 17c. per sq. ft., respectively.

Santa Ana, Cal.—Orange County Engineering & Contracting Co. has been awarded contract for construction of asphalt pavement on concrete base on Walnut street.

Santa Clara, Cal.—The following bids were received for construction of asphalt pavement on concrete base on State highway and on Homestead road: City Street Improvement Co., $35,047.01; Fay Improvement Co., $35,483; Clark & Henery Construction Co., $37,097.17; Ransome-Crummey Co., $37,148.65; Raisch Improvement Co., $37,184.17; W. A. Dontanville, $37,345.54; McGillivray Construction Co., $37,565.25; J. W. McDonald & Co., $38,127.33; Eaton & Smith, $38,847.84; Grace & Bernieri, $39,509.17; Blanchard-Brown Co., $39,864.45; E. H. Sundberg, $39,865; Johnson-Shea Co., $40,973.88; Marin Rock Co., $41,928; Paul & Caldwell, $43,167; and Teichert & Son, $43,873. Contract was awarded to City Street Improvement Co., 166 Geary street, San Francisco, for $35,047.

Seattle, Wash.—Board of Public Works will receive bids until April 7 for the following street work: paving 9th avenue West; and construction of water-mains on 43rd avenue Northeast.

Spokane, Wash.—Bids will be received until April 6 by L. Funk, Commissioner of Public Works, for paving 24th avenue. Plans from city engineer Morton Macartney.

Standard Asphalt Paving Co. was low bidder at $55,357 for construction of asphaltic concrete on macadam pavement on 5½ miles of Meadow Lake-Cheney road. Other bidders were: Spokane Asphalt Macadam Paving Co., $96,750; Spokane Bitumass Paving Co., $57,864; and Mitchell Bros. & Payne, $58,417. Spokane Asphalt Macadam Paving Co. bid $47,900 and Mitchell Bros. & Payne, $46,635 on asphalt macadam.

Stevenson, Wash.—Bids will be received until 1:30 p.m., April 15, by C. H. Nellor, county auditor, for construction of highway from Clark county line to Cascades.

Turlock, Cal.—City engineer has prepared plans for concrete pavement on Lander avenue and for Park street sewer.

Walla Walla, Wash.—Bids will be received until April 4 by M. A. Power, city clerk, for construction of 44,000 sq. yd. of pavement on several streets. W. R. Rehorn is city engineer.

Watts, Cal.—Bids will be received until 7:30 p.m., April 4, by A. D. Franklin, city clerk, for construction of 6000 sq. ft. of cement sidewalks.

Yuma, Ariz.—Board of Supervisors will receive bids until 10 a.m., April 4, for construction of highway structures, including 5370 cu. yd. reinforced concrete in culverts, and one 84-ft. wooden bridge.

SEWERS AND DRAINAGE

Berkeley, Cal.—City Council has authorized expenditure of $2500 for construction of 24-in. sewer, either vitrified pipe or concrete, on Hearst avenue. J. J. Jessup is city engineer.

Calexico, Cal.—Bids will be received until 7:30 p.m., April 4, by E. B. Browne, city clerk, for construction of extensions to sewer system, including about 20,000 ft. of 6 and 8-in. vitrified pipe sewer. Plans from city clerk upon payment of $5.

Long Beach, Cal.—Contract for construction of sewer laterals in district No. 1 has been awarded to P. S. Tomich, 311 North Hill street, for $11,970.

Midvale, Utah.—Bids will be received until 11 a.m., April 18, by H. S. Bennett, city recorder, for construction of sewer, septic tanks, and outfalls. Plans from city engineer John L. Griffith, Midvale, or 1596 Tenth East street, Salt Lake City, upon deposit of $5.

Polson, Mont.—Contract for construction of sewer system has been awarded to Security Bridge Co., Billings, for $25,000.

Puyallup, Wash.—City engineer G. D. Ball has prepared plans for drainage system costing $31,000.

Riverside, Cal.—Petition for formation of Perris-Brownlands drainage district consisting of 6000 acres has been granted. Riverside Trust Co. is interested.

San Jose, Cal.—All bids for excavating open ditch and for furnishing and laying 287,910 ft. of tile drain on the Rea property near Gilroy have been taken under advisement. The bids were considerably higher than expected and there is some doubt as to what will be done. Henry B. Fisher, Rea Bdg., is engineer.

Santa Cruz, Cal.—Contract for construction of sewers on Palm street has been awarded to B. Byrne at $0.55 per lin. ft. for furnishing and laying 6-in. sewer, $30 each for manholes, and $0.20 each for Y branches; a total of $438.34.

Stockton, Cal.—Contract for construction of storm sewers on several streets has been awarded to W. S. Gause for $13,710.99.

Contract for construction of sewers on several streets has been awarded to Chambers & Heafy, Bacon Bdg., Oakland, for $18,383.67. Engineer's estimate was $21,640.20.

Walla Walla, Wash.—Contract for sewer construction has been awarded to Wood & De Camp, Spokane, at the following unit prices: 15-in. sewer, $1.20 per ft.; 12-in. sewer, $0.89 per ft.; 10-in. sewer, $0.70 per ft.; 8-in. sewer, $0.59 per ft.; 6-in. sewer, $0.41 per ft.; manholes, $40 each; 15-in. wyes, $2.90 each; 12-in. wyes, $1.98; 10-in. wyes, $1.58; 8-in. wyes, $1.08; and 6-in. wyes, $0.72 each; a total of $7009.71. Other bidders were: O'Rourke Bros., $7436.98; H. L. Wilson Co., $7563.35; Pacific S. & W. Co., $7918.55; George Gordon Co., 8116; G. H. Sutherland Co., $8118.03.

BRIDGES AND CULVERTS

Hanford, Cal.—Bids will be received until 10:30 a.m., April 6, by Board of Supervisors for construction of bridges and culverts on Lemoore-Stratford highway. Work includes 562.7 cu. yd. class A concrete, 106.4 cu. yd. class B concrete, and 35,671 lb. reinforcing steel.

Kalama, Wash.—Bids will be received until April 3 by County Commissioners for construction of highway trestle at Oak Point.

Montesano, Wash.—County Commissioners will receive bids until April 17 for the construction of three highway bridges.

Odessa, Wash.—Bids will be received until May 1 by M. W. Nevins, city clerk, for construction of three bridges, one steel with a wooden floor, one steel with a concrete floor, and one concrete bridge. Plans from city clerk upon deposit of $10.

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Sacramento, Cal.—State Highway Commission will receive bids until 2 p.m., April 17, for construction of a bridge across the Eel river near Scotia, consisting of two steel truss spans each 302 ft. long, with reinforced concrete approaches, total length of bridge about 893 ft. The material needed will be 424 cu. yd. class A concrete, 4775 cu. yd. class C concrete, 6840 lin. ft. reinforced concrete piles, 415 tons structural steel, 72 tons reinforcing steel, 7 tons steel castings, 7485 lb. hardware and nails, 520 lin. ft. pipe railing, 90,000 ft. B. M. redwood timber. Copies of plans may be obtained from the Commission upon payment of $0.63. Remittances should be made payable to Forrest Blue Print Company.

Santa Barbara, Cal.—Board of Supervisors will receive bids until 10 a.m., April 3, for construction of reinforced concrete bridge on State highway across Zaca creek. Plans from county surveyor upon deposit of $10.

Yuba City, Cal.—Election will be called to vote on bond issue of $300,000; $280,000 for construction of bridges and $20,000 for building hospital.

IRRIGATION AND WATER SUPPLY

Aberdeen, Wash.—Contract for furnishing gate-valves for Wishkah pipe-line has been awarded to Carbet-Evans Steam Specialty Company.

Contract for furnishing steel bands and shoes for wood-stave pipe has been awarded to Portland Wood Pipe Co., 24th and York streets, Portland, Ore., for about $20,000.

Colfax, Wash.—Bids will be received until April 3 by T. J. Welty, city clerk, for furnishing 29,000 lin. ft. of 12-in. water-pipe.

Culver, Ore.—Irrigation district in north unit of Deschutes project has been formed. District will contain 100,000 acres and the estimated cost of construction is $55 per acre.

Echo, Ore.—Bids will be received until April 14 by rank Sloan, secretary Paradise irrigation district, for construction of irrigation system for district.

Gateway, Ore.—Irrigation district has been formed of land in this vicinity.

Milwaukie, Ore.—Contract for construction of water system has been awarded to Giebisch & Joplin, Rothchild Bdg., Portland, for $15,906,85.

Oregon City, Ore.—Water Board will construct 5,000,000-gal. reservoir. Estimated cost is $40,000.

Paradise, Cal.—Election will be called in Paradise irrigation district to vote on bond issue of $100,000 for construction of first unit of irrigation system. Total cost of work is estimated at $275,000. Richard White, Waterland Bdg., Chico, is attorney for district.

Riverside, Cal.—Southern Sierras Power Co. will join city in construction of dam to divert Santa Ana river into its old channel near Mt. Vernon avenue bridge.

San Luis Obispo, Cal.—Contract for furnishing 3400 ft. of water pipe to city has been awarded to Brookshire Oil Company.

Sunnyvale, Cal.—Town engineer F. P. McCray is preparing plans for booster pump for municipal water plant.

RAILROAD WORK

Hoquiam, Wash.—Contract for grading 6000 lin. ft. of railroad for Wynooche Timber Co. has been awarded to M. D. Hogan.

Medford, Ore.—S. S. Bullis, of Southern Oregon Traction Co., proposes that city shall issue $250,000 worth of bonds and with the proceeds construct railroad from present terminus of traction company line toward Blue Ledge mine. The traction company will then construct railroad from the end of the city road to the mine, and it agrees to lease the city road with option to purchase at end of five years.

Roseburg, Ore.—State Supreme Court has declared contract between city of Roseburg and Roseburg & Eastern railway void. This contract provided for the city's contributing $300,000 toward the building of a railroad, the total cost of which was to be about $600,000.

BUILDING CONSTRUCTION

Alameda, Cal.—C. C. Boynton and B. A. Minor will construct $50,000 bathhouse on South Park street.

Crockett, Cal.—Contract for sheet metal work and plumbing at the new concrete warehouse of California-Hawaiian Sugar Co. has been awarded to Yager Sheet Metal & Plumbing Co., 3509 Chestnut street, Oakland, for $4485.50.

Fresno, Cal.—Bids will be received until 9 p.m., April 3, by W. H. Ryan, city clerk, for remodeling basement of city hall.

Los Angeles, Cal.—Contract for construction of main building for Los Angeles high-school has been awarded to Barber Bradley Construction Co., 1824 East 15th street, for $395,652.

Portland, Ore.—Bids will be received until 4 p.m., April 6, by R. H. Thomas, 401 Court House, for construction of second unit of Franklin high school. Plans from F. A. Naramore, 303 Court House, upon deposit of $25.

Red Bluff, Cal.—James L. McLaughlin, 244 Kearny street, San Francisco, was low bidder at $68,233 for construction of school building. McLeran & Peterson bid $69,365.

San Bernardino, Cal.—All bids for construction of county hospital have been rejected because they exceed amount of money available.

San Francisco, Cal.—State Board of Harbor Commissioners have awarded contract for construction of pier No. 44 to S. B. Peterson, 742 Market street, for $28,950.

San Jose, Cal.—Election has been called for April 28 to vote on bond issue of $150,000 for construction of school buildings.

Seattle, Wash.—Contract for construction of Lowell school has been awarded to W. B. Lance, North Bank Bdg., for $56,200.

MISCELLANEOUS

Bakersfield, Cal.—Bids will be received until 5 p.m., April 3, by Wallace Morgan, city manager, for furnishing 4000 barrels of road oil, not lighter than 13°B. gravity.

Calexico, Cal.—Bids will be received until 7:30 p.m., April 4, by E. B. Browne, city clerk, for furnishing 275 tons of 4, 6, and 8-in. cast-iron pipe, 1000 ft. of 2-in. screw pipe, 1500 ft. of 1-in. pipe, and 2000 ft. of ¾-in. pipe. Plans from city clerk upon payment of $5.

Hollister, Cal.—County surveyor W. A. Winn is preparing plans for sprinkling system on Tres Pinos-Paicines road.

King City, Cal.—Expenditure of $10,000 for bank protection along Salinas river is proposed. H. T. Cozzens, county surveyor, Salinas, is preparing plans.

Los Angeles, Cal.—The following bond issues have been proposed: $1,350,000 for sewage disposal plants, $750,000 for firehouse sites and buildings, $450,000 for fire and police alarm system, $1,000,000 for grade crossing elimination, $5,000,000 for completion of municipal power plant and distribution system, $1,500,000 for harbor improvements, and $10,000,000 for purchase of Sunset telephone system.

Petaluma, Cal.—Contract for dredging channel of Petaluma river has been awarded to American Dredging Co., 21 California street, San Francisco.

San Francisco, Cal.—Bids will be received until 11 a.m., April 13, by Leo V. Merle, Jr., secretary Board of Harbor Commissioners, room 17, Ferry Bdg., for furnishing douglas fir piles.

Bids will be received until 11 a.m., April 29, at U. S. Engineer Office, 401 Custom House, for dredging in Petaluma creek.

Contract for removing wreck of steamer 'City of Panama' from bay has been awarded to M. A. Taylor, foot of 9th street, Oakland, for $9280.

San Luis Obispo, Cal.—Bids will be received until 7:30 p.m., April 3, by city clerk C. M. John, for furnishing street sprinkler.

Silverton, Ore.—Silver Falls Timber Co. will construct $400,000 lumber mill.

Washington, D. C.—Bids will be received until 11 a.m., April 3, by C. E. Dole, purchasing agent, Alaska Engineering Commission, Seattle, Wash., for furnishing 4800 tons of bituminous coal. Particulars from circular No. 159, which may be obtained from Bureau of Mines, 506 Custom House, San Francisco.

Bids will be received until 10:30 a.m., April 21, at office of General Purchasing Agent, the Panama Canal, for furnishing lubricating oils and greases for the year ending June 30, 1917.

Yreka, Cal.—Bids will be received until 7:30 p.m., April 6, by U. F. Brown, city clery, for furnishing 400 lin. ft. of 4-in. standard screew galvanized iron pipe.

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